THE

AMERICAN NATURALIST

VOL. XXVIII. March, 1894. 327

THE ENERGY OF EVOLUTION.

BY E. D. COPE.

1 PRELIMINARY.

In considering the dynamics of organic evolution, it will be convenient to commence by considering the claims of Natural Selection to include the energy which underlies the process. That Natural Selection cannot be the cause of the origin of new characters, or variation, was asserted by Darwin;[1] and this opinion is supported by the following weighty considerations.

(1) A selection cannot be the cause of those alternatives from which it selects. The alternatives must be presented before the selection can commence.

(2) Since the number of variations possible to organisms is very great, the probability of the admirably adaptive structures which characterize the latter having arisen by chance is extremely small.

(3) In order that a variation of structure shall survive, it is necessary that it shall appear simultaneously in two individuals of opposite sex. But if the chance of its appearing in one individual is very small, the chance of its appearing in two individuals is very much smaller. But even this concurrence of chances would not be sufficient to secure its survival, since it would be immediately bred out by the immensely prepon-

[1]Origin of Species, Ed. 1872, p. 65.

derant number of individuals which should not possess the variation.

(4) Finally, the characters which define the organic types, so far as they are disclosed by paleontology, have commenced as minute buds or rudiments, of no value whatsoever in the struggle for existence. Natural Selection can only effect the survival of characters when they have attained some functional value.

In order to secure the survival of a new character, that is, of a new type of organism, it is necessary that the variation should appear in a large number of individuals coincidentally and successively. It is exceedingly probable that that is what has occurred in past geologic ages. We are thus led to look for a cause which affects equally many individuals at the same time, and continuously. Such causes are found in the changing physical conditions that have succeeded each other in the past history of our planet, and the changes of organic function necessarily produced thereby.

2 Bathmogenesis.

If we view the phenomena of organic life from the standpoint of the physicist, the first question that naturally arises in the mind is as to the kind of energy of which it is an exhibition. Ordinary observation shows that organic bodies perform molar movements, and that many of them give out heat. A smaller number exhibit emanations of light and electricity. Very little consideration is sufficient to show that they include among their functions chemical reactions, a conviction which is abundantly sustained by researches into the physiology of both animals and plants. The phenomena of growth are also evidently exhibitions of energy. The term energy is used to express the motion of matter, and the building of an embryo to maturity is evidently accomplished by the movement of matter in certain definite directions. The energy which accomplishes this feat is, however, none of those which characterize inorganic matter, some of which have just been mentioned, but, judging from its phenomena, is of a widely different character. If we further take a broad view of the general

process of progressive evolution, which is accomplished by successive modifications of this growth-energy, we see further reason for distinguishing it widely from the inorganic energies.

It is customary to distinguish broadly between inorganic and organic energies, as those which are displayed by non-living and living bodies. This classification is inexact, since, as already remarked, nearly all of the inorganic energies are exhibited by living beings. A division which appears to be, with our present knowledge, much more fundamental, is into the energies which tend away from, and those which tend towards, the phenomena of life. In other words, those which are not necessarily phenomena of life, and those which are necessarily such. And the phenomena of life here referred to are the phenomena of growth and evolution, as distinguished from all others. I have termed[2] these classes the Anagenetic, which are exclusively vital, and the Catagenetic, which are physical and chemical. The Anagenetic class tends to upward progress in the organic sense; that is, toward the increasing control of its environment by the organism, and toward the origin and development of consciousness and mind. The Catagenetic energies tend to the creation of a stable equilibrium of matter, in which molar motion is not produced from within, and sensation is impossible. In popular language the one class of energies tends to life; the other to death.

That the Catagenetic energies whether physical or chemical, tend away from life is clear enough. Thus molar motion unless continuously supplied, or directed by a living source, speedily ceases, being converted by friction into heat, which is dissipated. And were we to suppose a case where friction is non-existent, motion would remain molar, and no phenomena of organic life would result, and sensation could not arise. The same is true of molecular movements under the same conditions. Chemical reactions, which are fundamental in world-building, result in the production of solids and the radiation of heat. The most familiar example, that of oxydation, presents us with the case of a gas becoming a liquid

[2] The Monist Chicago, 1893, p. 630.

or a solid with the evolution of heat. The endothermic reaction, where matter undergoes a change of molecular aggregation the reverse of that just mentioned, with the absorption of heat, as in the case of several hydrogen compounds, is rare in nature, where free from organic complications, and is generally soon reversed by further reactions. Finally cosmic creation involves the perpetual radiation of heat into space, and the gradual reduction of all forms of matter to the solid state.

In the anagenetic energies, on the other hand, we have a process of building machines, which not only resist the action of catagenesis, but which press the catagenetic energies into their service. In the assimilation of inorganic substances they elevate them into higher, that is more complex compounds, and raise the types of energy to their own level. In the development of molar movements they enable their organisms to escape many of the destructive effects of catagenetic energy, by enabling them to change their environment; and this is especially true in so far as sensation or consciousness is present to them. The anagenetic energy transforms the face of nature by its power of assimilating and recompounding inorganic matter, and by its capacity for multiplying its individuals. In spite of the mechanical destructibility of its physical basis (protoplasm), and the ease with which its mechanisms are destroyed, it successfully resists, controls, and remodels the catagenetic energies for its purposes.

The anagenetic power of assimilation of the inorganic substances is chiefly seen in the vegetable kingdom. Atmospheric air, water and inorganic salts furnish it with the materials of its physical basis. Then from its own protoplasm it elaborates by a catagenetic retrograde metamorphosis, the mostly non-nitrogenous substances, as wood (cellulose), waxes, oils and alkaloids, and it may take up inorganic substances and deposit them without alteration in its cells. Many of the compounds elaborated by plants and animals have been manufactured of latter time by chemists. The discovery that the living organism is not necessary for the production of these substances has led to the hasty conclusion that the supposed distinction between "organic" and "inorganic" energy does not exist. But the

elaboration of these substances is not accomplished by anagenetic or "vital" energy, but by a process of running down of the higher compound protoplasm, which is catagenesis. No truly anagenetic process has yet been imitated by man.

All forms of functioning of organs, except assimilation, reproduction and growth, are catagenetic. That is, functioning consists in the retrograde metamorphosis of a nitrogenous organic substance or proteid with the setting free of energy. The proteid is decomposed in the functioning tissue into carbon dioxyd, water, urea, etc., and energy appears in the muscle as contraction, in the glands as secretion, and in all parts of the body as heat. The general result of physiologic research is, that the decomposition of the blood is the source of energy, while the tissue of each organ determines the character of that energy. That the tissue itself suffers from wear, and requires repair, is also true, but to a less extent than was once supposed.

In the anagenetic process of the growth of the embryo the case is different. Here the processes of functioning of organs are in complete abeyance, the nutritive substance is not entirely broken down in chemical decomposition, but it is in great part elaborated into tissues and organs. All the mechanisms necessary to the mature life of the individual are constructed by the activity of the special form of energy known as growth-energy or Bathmism. It is the modifications of this energy which constitute evolution, and it is these to which we will hereafter direct our attention. Its simplest exhibition is the subdivision of a unicellular protoplasmic body into two or more individuals or structural units of a multicellular organism. Further division of the latter does not abolish the individual, but extends it, and we now observe the elaboration of different structural types to become a conspicuous function of this form of energy. In other words a once simple energy becomes specialized into specific energies, each of which, once established, pursues its mode of motion in opposition to all other modes not more potent than itself. Besides the evident truth of the proposition than a mode of building is a mode of motion, we have another very good reason for believing in the existence

of a class of bathmic or growth-energies. This is found in the phenomena of heredity. The most rational conception of this inheritance of structural characters is the transmission of a mode of motion from the soma to the germ-cells. This is a far more conceivable method than that of the transmission of particles of matter, other than the ordinary material of nutrition. The bathmic theory of heredity bears about the same relation to a theory of transmission of the pangenes of Darwin, or the ids of Weismann, as the undulatory theory of light and other forms of radiant energy does to the molecular theory of Newton. I have therefore assumed as a working hypothesis the existence of the bathmic energy, and will enquire how far the facts in our possession sustain it. In doing so it will be necessary to elaborate the theory so as to render clearer its application to specific cases. The fact to be accounted for is its specialization into so many diverse specific forms.

A further indication of the existence of the bathmic energy is the quantitative limitation to which growth is obedient. Thus the successive stages of embryonic growth are limited in number in each species. The dimensions of many species are limited within a definite range. The duration of life, or of the functioning organic machine, has a definite limit in time. All this means that a certain limited quantity of energy is at the disposal of each individual organism.

In "The Origin of the Fittest," I have endeavored to show what causes have been and are efficient in the production of different types of organic life, through the modifications of the bathmic energy. We will now briefly consider to the question of the origin of the living substance, protoplasm or sarcode, which exhibits bathmism.

If the tendency of the catagenetic energies is away from vital phenomena, it is impossible that they, or any one of them, should be the cause of the origin of living matter. This logical inference is confirmed by the failure of all attempts to demonstrate spontaneous generation of living organisms from inorganic matter. Further, the principle of continuity leads us to infer that the energy which produced organic matter must be identical with or allied to that which is the efficient agent in pro-

gressive evolution of organisms, and is, therefore, anagenetic. Such a conclusion may seem to lead to a dualism which is itself opposed to the principle of continuity or uniformity, and which is opposed to experience of the phenomena of energy in general. How is uniformity to be harmonized with the hypothesis of two types of energy acting in different directions, apparently in opposition to each other? Since facts and logic do not support the derivation of the anagenetic from the inorganic energies, can the reverse process, the derivation of the catagenetic from the anagenetic be and have been the order of nature? In support of this hypothesis, we have the universal prevalence of the retrograde metamorphosis of energy in both the inorganic and organic kingdoms. Phenomena of structural degeneracy are well known in the organic world, and purely chemical phenomena in both organic and inorganic processes are all degenerate. It appears then much more probable that catagenesis succeeds anagenesis as a consequence, and does not precede it as a cause. In other words, it is more probable that death is a consequence of life, rather than that the living is a product of the non-living. I have therefore given to that energy which is displayed by the plant in the elaboration of living from now living matter the name of antichemism.[3] Thus while the heat of the sun is necessary to the building of protoplasm, within a certain range of temperature, this form of energy has its opportunity.

In order to present more clearly the views enunciated in the preceding pages, I give a synoptic table of energies.

I Anagenetic	Organic		Antichemism.
			Bathmism.
II Catagenetic	Exclusively organic		Neurism.
			Myism.
	Inorganic		Radiant Energy.
			Chemism.
			Cohesion.
			Gravitation.

3 The Forms of Bathmism.

The innumerable structures which are due to the activity of Bathmisms may be supposed to result from the composition of

[3] American Naturalist, 1884, p. 979. Origin of the Fittest, 1887, p. 431.

this energy with others which are present in the organism or in the environment, or both. Ryder has called the exhibition of growth energy Ergogenesis,[4] and he calls attention to the fact that it appears under two aspects. In the first, Ergogenesis is due to mechanical causes resident in the organism exclusively, and it expresses the sum of the bathmic energy inherited from the parents of the growing organism. To this conservative expression of Bathmism he gives the name of Statogenesis. In the second aspect of Ergogenesis, the course of growth (ontogeny) is determined by motion from sources external to the germ cell. It is this which modifies ontogeny and produces those changes of structure which constitute Evolution. To this aspect of growth I have given the name Kinetogenesis.[5] As Statogenesis expresses simple growth force, and Kinetogenesis the additional growth, which is evolution, the latter is chiefly considered here.

Kinetogenesis is of two kinds; viz., the changes in growth which are due to the interference of molecular energies only, and those which are due to molar movements. The former type of evolutionary growth I propose to call Physiogenesis; and I propose to restrict the term kinetogenesis to the latter class. To the total evolutionary energy or energies due to external interference, the Kinetogenesis of Ryder, I propose to apply the term Bathmogenesis. The relation of these modes, and their corresponding names may be expressed as follows:

$$\text{Ergogenesis} \begin{cases} \text{Statogenesis} \\ \text{Bathmogenesis.} \end{cases} \begin{cases} \text{Physiogensis.} \\ \text{Kinetogenesis.} \end{cases}$$

Statogenesis, I shall hereafter endeavor to show, is an automatic product of Bathmogenesis.

The first step in the order of Bathmogenetic action is the effect of stimuli on an animal which is no longer protected by the parent or by parental products (egg-shell) as an embryo. Changes may be effected in the weight, color, and in functional

[4] Proceeds. Amer. Philos. Soc. 1893, p. 194.

[5] Origin of the Fittest, 1887, p. 423. Statogenesis and Kinetogenesis are the equivalents of my Growth Force and Grade Growth Force, Proceeds. Amer. Philos. Soc. 1871, p. 253.

capacity by temperature, humidity, food, etc., thus exhibiting physiogenesis. Or changes in the size and form of parts of the body may be produced by movements of the organism, or of its environment, so displaying Kinetogenesis. So long as these modifications of structure should be confined to the individuals thus modified, there would be no evolution. A second generation, if not subjected to the same stimuli, would not possess the modifications; and their possession of them would depend entirely on the amount of stimulus. In other words there would be no accumulation of modification. It has, however, been generally believed that these modifications are inherited, and I think it can be shown that this belief rests on a solid basis. Meanwhile I call the Bathmogenesis which does not extend beyond the generation in which it appears, autobathmogeny.

The quantitative relation which necessarily exists between Bathmism and its sources may be expressed as follows, with due recognition of the fact that such expression does not rest upon any experimental tests. Statogenesis is work done in the construction of tissues like those of the parent and without interference. Here we have the molecular energy of the parent (either as protozoon or oösperm) temporarily converted in part into the molar movements observed to be concomitants of segmentation; to be represented in the completed tissue by the mutual tensions by virtue of which each structural element maintains its integrity. It is evidently a process of metamorphosis of energy in which there is less waste than in any other known to us. Embryonic growth is accompanied by a very slight dissipation of heat, though a slight rise of temperature is noticeable in the eggs of cold-blooded animals and in flowers, when reproduction is active. The products of breaking down are equally rare in embryonic growth, and both this and the dissipation of heat are evidently largely due to the changes wrought in non-cleavable nutritive substances with which the yolks are sometimes charged. It is probably to accomplish this process that the oxygen necessary for the embryonic growth is used. How much loss is due to cell division itself

is not known, but it must be very little if any. We have here a nearly perfect conversion of energy. Theoretically we have anagenesis wherever the up-building exceeds the down-breaking.

The attempt to realize in the imagination the modus operandi of bathmic energy in embryo building takes the following form. It is to be supposed that movement which has been most frequently repeated, and for the longest period, is prepotent, and takes precedence of all others. This is clearly simple cell division, which follows the nutrition supplied by the spermatozoön, and which represents the first act of animal life. Hence, segmentation of the oösperm is the first movement of bathmism. Each subsequent movement appears in the order of potency, which is, other things being equal, a time order, or the order of record. The cause of the localization of tissues and structures is much more difficult to understand than the cause of the order of their appearance. The more energetic part of the process naturally requires the greater space for its products. The ectoderm, which becomes the seat of the nervous axis and its muscular adjuncts, occupies the superficial portions of the yolk. Hence, we may regard this expression of the structural record of these functions as more energetic than that of the record structure of the nutritive functions, which displays itself below the ectoderm. In meroblastic and amphiblastic embryos, the segmentation which develops the nutritive tissues is evidently more sluggish, for the cells are larger and fewer in number than those of the ectoderm.

Can this difference in the segmentations which produce the ectoderm and the endoderm be due to a certain polarity; the male or energetic tendency predominating in the former, and the female in the latter?

External stimuli modify the course of statogeny above described, and by producing new structural records cause a new form of energy, due to composition of the new with the old, and the process of growth then becomes bathmogeny. The external stimuli are molecular or molar, determining physiobathmism or kinetobathmism.

The effect of motion or use on the soma may be conveniently termed autokinetogenesis. Moderate use of a muscle is known to increase its size. Irritation of the periosteum is known to cause deposit of bone. Friction and pressure of the epithelium increases its quantity or changes its form. Increased activity of the functions of nervous tissues increases their relative proportions, as in the enlargement of nerves which replace others which are interrupted by mutilations, etc. On the other hand, it is equally well known that disuse produces diminution of muscular tissue, and through it, a reduction in the quantity of the harder tissue (bone, chitin, etc.) to which it is attached, (as muscular insertions, etc.). It was the observation of such well-known phenomena as these that led Lamarck to advance his doctrine of evolution under use and disuse, and which has led many others to give their adherence to such a view.

Thus much for cell-growth. Another class of modifications of a similar kind may be found in the parts of an organism which consist of a complex of cells, or tissues. Thus the lumen of a small artery is enlarged under the influence of pressure when it is compelled to assume the function of a larger vessel through the interruption of the latter. A part of an internal or external skeleton which is fractured will form an artificial joint at the point of fracture, if the adjacent surfaces are kept in motion. Marey (Animal Mechanism pp. 88–89) says "After dislocations the old articular cavities will be filled up and disappear, while at the new point where the head of the bone is actually placed, a fresh articulation is formed, to which nothing will be wanting in the course of a few months, neither articular cartilages, synovial fluid, nor the ligaments to retain the bone in place." I have given some illustrations of this fact,[6] which have come under my observation, and which have an important bearing on the origin of the articulations of the vertebrate skeleton as I have traced them throughout geological time. I have as I think conclusively shown that these varied structures have been produced by impacts and strains, which are concomitants of the movements of the animals, acting through long periods of time.[7] I have also proposed the

[6] Proceeds. Amer. Philos. Soc. 1892, p. 285.

[7] Mechanical Origin of the Hard parts of the Mammalia, Amer. Journal of Morphology, 1889. Origin of the Fittest, 1887, pp. 305-373.

hypothesis, that such Kinetogenetic organic energies as are not under the control of the organism, are the product of the catagenesis of energies which were at one time under such control.

4 Mnemogenesis.

The above term is employed by Prof. Hyatt[8] to characterize the manner in which kinetogenesis is supposed to produce results in inheritance. I have suggested that the phenomena of recapitulation, characteristic of ontogeny (Amer. Naturalist, Dec., 1889), are due to the presence of a record in the germ cells, having a molecular basis similar to that of memory. This view is adopted by Professor Hyatt. I have already referred to it in the preceding pages. The stimuli which are thus recorded are those which produce growth effects in the body or soma, so that each stimulus may have a double influence. For this reason I have termed this theory of the distribution of energy, Diplogenesis (loc. cit.).

The first statement of the mnemonic theory of heredity which I can discover, is that made by Hering in 1870.[9] It is concentrated in the following paragraph: "The appearance of properties of the parental organism in the full-grown filial organism can be nothing else but the reproduction of such processes of organized matter as the germ when still in the germinal vesicles had taken part in; the filial organism remembers, so to speak, those processes, as soon as an occasion of the same or similar irritations is offered a reaction takes place as formerly in the parental organism, of which it was then a part and whose destinies influenced it." In explanation of this theory Hering says: "We notice, further on, that the process of development of the germs which are destined to attain an independent existence, exercises a powerful reaction upon both the conscious and unconscious life of the whole organism. And this is a hint that the organ of germination is in closer and more momentous relation to the other parts, especially to the nervous system, than another organ. In an inverse ratio the conscious and unconscious destinies of the whole organism,

[8] Proceeds. Boston Soc. Nat. Hist. 1893, p. 73.

[9] Address before the Imperial Academy of Sciences of Vienna, May 30, 1870, by Edwald Hering.

it is most probable, find a stronger echo in the germinal vesicles than elsewhere."

It is evident that evolutionists are reaching greater harmony of opinions on the question of inheritance, for both sides are adopting the doctrine of Diplogenesis. In fact, the discussion is beginning to be a logomachy dependent on the significance which one attaches to the term, "acquired characters." Thus, Vom Rath, who says he does not believe in the inheritance[10] of acquired characters, remarks: "there is nothing in the way of the opinion that by the continual working of such external influences and stimuli, the molecular structure of the germ-plasma also experiences a change which can lead to a transmission of transformations. Above all, it ought not to be forgotten in this case that the somatic cells are in no way the first to be modified by the stimulus, and that then by some sort of unexplained process (pangenesis or intercellular pangenesis) this stimulus is transmitted generally by these cells to the plasma of the germ cells. The influence on the germ-plasma is rather a direct one, and if by continued influence a transformation of the structure of this plasma takes place and transmission occurs, we have then simply a transmission of blastogenic and by no means of somatogenic characters, and therein is not the slightest admission of the transmission of acquired characters."

This surprising paragraph contains an admission of the doctrine of Diplogenesis, and does not regard the phenomena as including a transmission of acquired characters. Nevertheless, the stimuli traverse the soma in order to reach the germ plasma. Such an energy is evidently then not of blastogenic origin, although it is such in its effects. Moreover, Vom Rath omits to mention the fact that in traversing the soma, the stimulus frequently, if not always, produces effects on the latter similar to those which it produces on the germ plasma. I should call this process the inheritance of an acquired character, even in the case where no corresponding modification appears in the soma, since the causative energy is acquired by the soma, and is not derived from the existing germ plasma.

[10]Berichte der Naturforsch. Gessel. zu Freiburg Baden. Bd. VI, H. 3.

Romanes[11] says, in revising the opinions of Weismann, "(1) Germ Plasm ceases to be continuous in the sense of having borne a perpetual record of congenital variations from the first origin of sexual propagation. (2) On the contrary, *as all such variations have been originated by the direct action of external conditions*" (italics mine) "the continuity of the germ plasm in this sense has been interrupted at the commencement of every inherited change during the phylogeny of all plants and animals, unicellular as well as multicellular. (3) But germ plasm remains continuous in the restricted though highly important sense of being the sole repository of hereditary characters of each successive generation, so that acquired characters can never have been transmitted to progeny, 'representatively,' even though they have frequently caused those 'specialized' changes in the structure of the germ plasm, which, as we have seen, must certainly have been of considerable importance in the history of organic evolution."

Here the inheritance of characters acquired by the soma is admitted, and the process is after the method of Diplogenesis. According to Romanes, Galton originally propounded this doctrine. Galton's language[12] is as follows:

"It is said that the structure of an animal changes when he is placed under changed conditions; that his offspring inherit some of his change, and that they vary still further on their own account, in the same direction, and so on through successive generations until a notable change in the congenital characteristics of the race has been effected. Hence, it is concluded that a change in the personal structure has reacted on the sexual elements. For my part, I object to so general a conclusion for the following reasons. It is universally admitted that the primary agents in the processes of growth, nutrition and reproduction, are the same, and that a true theory of heredity must so regard them. In other words, they are all due to the development of some germinal matter variously located. Consequently, when similar germinal matter is everywhere affected by the same conditions, we should

[11]An Examination of Weismannism, Chicago, 1892, p. 169.

[12]Contemporary Review, 1875, pp. 343–4; Proceeds. Royal Soc., 1872, no. 136.

expect that it would be everywhere affected in the same way. The particular kind of germ whence the hair sprang that was induced to throw out a new variety in the cells nearest the surface of the body under certain changed conditions of climate and food, might be expected to throw out a similar variety in the sexual elements at the same time. The changes in the germs would everywhere be collateral, although the moments when any of the changed germs happen to receive their development might be different." This is the first statement of the doctrine of Diplogenesis with which I have met and it appears to me to furnish the most rational basis for the investigation into the dynamics of the process.

THE CLASSIFICATION OF THE ARTHROPODA.

By J. S. Kingsley.

(*Continued from page* 135, *February, 1894.*)

Sub-Class II—Eucrustacea.

Crustacea, with filiform, plumose or lamellate gills, in either thoracic or abdominal region; mouth parts never ambulatory in the adult, but modified for the prehension and comminution of food. Nauplius stage either free-swimming or passed in the egg.

It is difficult, with our present knowledge, to find good diagnostic points separating the true Crustacea from the Trilobites, and it may be that further research will show that the latter are to be regarded as a division equivalent to some of those mentioned below. At present, the arrangment of the feet of the cephalic region in a circle around the mouth, the use of their basal joints for the comminution food, and the apparent functioning of the distal joints as locomotor organs, together with the peculiar gills, must serve to differentiate the two groups, it being understood that the ideas here expressed are merely provisional.

In the sub-division of the Crustacea I am inclined to adopt the recent "sub-classes" of Grobben ('92) as super-orders as follows:

Super-Order I, Phyllopoda.
  Order I, Euphyllopoda.
  Order II, Cladocera.
Super-Order II, Estheriæformes.
  Order I, Ostracoda.
Super-Order III, Apodiformes.
  Order I, Copepoda.
  Order II, Cirripedia.
Super-Order IV, Malacostraca sive Branchipodiformes.

I, Leptostraca.
Order I, Nebaliadæ.
II, Eumalacostraca.
Order I, Stomatopoda.
Order II, Thoracostraca.
Order III, Arthrostraca.

On the whole, I accept the conclusions of Grobben as to the relationships of the various groups, and have, like many other zoologists, regarded the Phyllopods as the ancestral stock. I think that this is shown by, among other points, the structure of the appendages, regarding which I fully accept the conclusions of Lankester[2] ('81). I do not regard the nauplius stage as indicative of a naupliform ancestor, but as an introduced feature, for which view the arguments adduced by Claus and Dohrn, seem valid. The ancestor of the Phyllopods must have been an elongate poly-somitic animal with lamellate appendages, the basal portions of one or more "legs" serving at the same time as both locomotor and manducatory organs. In short, my views as to the ancestral form are much like those adopted by Bernard ('92), although I cannot accept all of his conclusions as to the steps of the evolution.

Class II—Acerata.

Branchiate Arthropods, in which the branchial folds, developed from the abdominal appendages function as gills, as lungs, or as tracheæ. The body is divided into cephalothorax and abdomen, the line passing behind the sixth pair of appendages. The genital ducts open upon the first abdominal somite. The anterior postoral ganglia unite to form a ganglionic ring aronnd the œsophagus; the median eyes are in-

[1] I regard Packard's ('87) Syncarida as a group of Amphipoda of scarcely more than family rank.

[2] Grobben does not accept Lankester's views, and claims that embryology shows that Lankester's sixth endite is the endopodite and the flabellum the exopodite, in support of which he cites the observations of Claus ('73, p. 20). I cannot find there or anywhere else in Claus' paper any evidence which is not capable of being interpreted in full harmony with Lankester's view that the 5th and 6th endites of the Phyllopod limb are endopodite and exopodite respectively, while the flabellum is the homologue of the epipodite of the "typical" Crustacean limb.

vaginate. The entoderm (at least in several types) arises by delamination; there is a large mid-gut, with well-developed glands ("liver") while the proctodeum is short. The genital glands are reticulate and the spermatozoa are motile.

There is little to be said upon the foregoing points, to which many more, applicable to both Xiphosures and some Arachnids, might be added. The exact serial correspondence of the respiratory metameres in Limulus and the Scorpions have been enlarged upon by Lankester ('81[a]), and considerable emphasis must be placed upon the fact that in all Arachnids the stomata are ventral, and are, in all instances, except in possibly the Solpugids and a few mites, are confined to the abdomen. These exceptions need new study. In the Scorpion, as in Limulus, the observations of Narayanan ('89) and Laurie ('90) show that the genital ducts are modified nephridia, and that they open upon the posterior surface of the first abdominal appendages. Delamination has been shown to occur in the Pseudoscorpions, Araneina, Phalangids and Limulus, as well as in the doubtfully Arachnidan Pycnogonids.

Sub-Class I—Gigantostraca seu Merostomata.

Six pairs of cephalothoracic limbs around the mouth, the bases of the posterior pairs being masticatory. Behind the mouth a metastomial plate or pair of plates. Anterior edge of carapax acute, its upper surface bearing median ocelli and a pair of lateral compound eyes. Respiration by means of lamellate branchiæ (gill books) borne on appendages 2–6 of the abdomen and protected by the enlarged first pair (operculum) which covers them.

To these points, which cover both Xiphosures and Eurypterids, the following, derived from Limulus, may be added: No salivary glands, no Malpighian tubes, no embryonic membranes (amnion).

In this sub-class two orders are to be recognized, the Eurypterida (fossil) and the Xiphosures. In the latter are included the recent and fossil Limuloid forms. The difference between these is not readily formulated, but is readily recognized in the specimens. The affinities of Cyclus are uncertain.

Order I—Xiphosura.

Cephalothorax large, metastoma paired, telson elongate and spiniform,

Sub Order I—Limulidæ.

Abdominal somites six, coalesced.

Sub-Order II—Hemiaspida.

Abdominal somites more than six, free.

Order II—Eurypterida.

Cephalothorax small, abdomen large and elongate, twelve-jointed, the joints free, telson spatulate, metastoma unpaired.

Sub-Class II—Arachnida.

Respiration by internal lungs or tracheæ, no compound eyes Entodermal Malpighian tubes present; Embryonic membrane (amnion) present in some.

I regard the Scorpionida as the most primitive type of Arachnida existing to-day, and the Acarina as the farthest removed from the original stem. This position of the Scorpions is shown by many facts of structure; and the pulmonate type of respiration—intermediate between the gills of the Gigantostraca and the tracheæ of the higher Arachnids—occuring in these forms is just what we should expect if the line of descent is, as here maintained, from branchiate forms. On the other hypothesis of a common origin of all "Tracheates" from some Peripatoid form, we should have the strange spectacle of the most primitive of all Arachnids with the most differentiated respiratory system.

In the Arachnida I recognize the following orders:[3]—I, Scorpionida; II, Thelyphonida; III, Araneida, IV, Solpugida;[4] V, Pseudoscorpii; VI, Phalangida; VIII, Acarina.

It is interesting to note in this connection that Pocock, on morphological grounds points out (Ann. & Mag, Nat. Hist., VI,

[3] In this I follow the order of Pocock (Ann. & Mag. N. H., Jan., 1893). His "sub-classes" Ctenophora, Lipoctena and super ordinal divisions Chaulogastra, Mycetophora and Holostomata are hardly to be regarded as of phylogenetic value.

[4] No group of Archnids will better repay study than this. I do not believe that the distinction between the "head" and the "thorax" with its three distinct somites indicates any affinities with the Hexapods, but that the conditions here existing are to be best explained upon the ground of homoplassy. The position of the anterior stigmata in the first thoracic somite is of great interest,

xi, p. 2) that "the immediate ancestor of the Arachnida was constructed somewhat as follows: The body was composed of eighteen somites, the anterior of which were provided with large appendages set apart for locomotion and the prehension and mastication of food; the terga of this cephalothoracic region were fused to form a single shield or carapace, supporting a submedian and a cluster of lateral eyes at each side, and the ventral surface of the carapace [? cephalothorax], at least in its posterior half, was protected by a sternal plate. Each of the succeeding six somites bore a pair of small ventral appendages, and the generative aperture opened upon the sternal area of the first of these somites. The posterior six somites had lost their appendages, were probably narrower than the rest, and constituted a limbless caudal portion of the body, the last of them being furnished with a single plate, articulated above the anal aperature." This should be compared with one of the Eurypterida.

Sub-Phylum II—Insecta sive Antennata.

Arthropods with differentiated head consisting of procephalic lobes and four (five[5]) somites; head with somites anchylosed and provided with four pairs of appendages modified for sensation or for feeding; respiration by means of tracheæ (modified glands) opening to the exterior on the sides of the body in the post-cephalic region. Nephridia absent, except as genital ducts, which open near the posterior extremity of the body. Ectodermal Malpighian tubes present. Spermatozoa motile.

So far as I am aware, the dissolution of the old group Myriapoda and the union of the Chilopoda with the Hexapoda was first proposed by Pocock ('87). At about the same time, I taught the same view to my classes, and later ('88) published the same. Subsequently both Pocock ('93) and I ('93, p. 248 ff.) repeated our views within a month of each other.[6] This step, it seems to me, is fully justified. The affinities of the Chilopods to the Hexapods are most close, while those of Chilopoda and

[5] See p. 125.

[6] One of our best students of the Myriapoda, the late C. H. Bollman, accepted my views and they appear in the posthumous collection of his papers ('93).

Chilognatha are quite obscure. There has been no greater stumbling-block for morphologists than the attempt to homologise the somites of millipeds and centipedes. Attempts to bring other organs into harmony are equally futile. The three groups under discussion may be contrasted as follows, it being of course admitted that we know next to nothing of the somites and serial homologies of either Diplopod or Chilopod, and that possibly future research will modify some of the statements below.

The Diplopod head bears, besides the antennæ, but two pairs of appendages—a pair of mandibles and a lower lip, composed of a pair of coalesced maxillæ.[7] In the Chilopod the conditions are as in the Hexapod, two pairs of maxillæ being present.

In the Chilopods, as in the Hexapods, each somite bears a single pair of appendages, while in the Diplopods the majority of the segments bear two pairs of appendages, and the researches of Heathcote ('88) show that each segment is, in reality, composed of two coalesced somites, a condition without parallel elsewhere in the Arthropoda. In the Chilopods there is a wide sternum separating the coxæ of the ambulatory appendages; in the Diplopods the coxæ are approximate, and the sternum is exceeding narrow, or even entirely absent.

In the Chilopods the stigmata, a pair to a somite, are lateral (dorsal in Scutigera), and are placed above and outside the insertion of the limbs, exactly as in the Hexapods. The tracheæ which arise from them are branched, and the intima is thrown into a well-developed spiral thickening as in the six-footed insects. In the Diplopoda, on the other hand, the stigmata are beneath the body[8] close to the legs, while the tracheæ (ex-

[7] The attempt made to show that this lower lip is composed of the two coalesced lower jaws, or first and second maxillæ, of the Chilognaths receives no support from the embryology of Julus (Heathcote '88), where there is but a single somite when the hypothesis calls for two. Further the innervation of the sense organs of the lower lip (*cf.* vom Rath, '86, Pl. XX, Fig. 1) shows that but a single pair of appendages is concerned in the part.

[8] In former papers I have said that the spiracles might be even *in* the coxæ. I recall having seen this statement but recently rather rather extensive reading of Myriapod literature fails to reveal my authority.

cept in the Glomeridæ) are tufted and unbranched, and the thickening of the intima is poorly developed.

In the Diplopods there are well-developed foramina repugnatoria upon the sides of each somite of the body. Such structures are absent from the Chilopods (as from the Hexapods), except in a few Geophilidæ, where repugnatorial glands occur, opening by foramina in the mid-ventral line.

In the Chilopods the reproductive organs consist of paired[9] gonads situated above the alimentary canal and opening to the exterior by ducts which are at first paired, but which later unite into a common tube which leads to a single external opening situated in the penultimate segment of the body. In the Hexapods the conditions are almost exactly the same; the gonads are dorsal, the genital ducts unite (except in Ephemeridæ), and there is a single external opening, always at the posterior end of the abdomen. In both Hexapods and Chilopods the spermatozoa are motile. In the Diplopods there is a single unpaired gonad, situated beneath the alimentary canal, and the genital duct, passing forward, divides into two, each of which has its own opening at the bases of the legs of the second post cephalic segment. The spermatozoa are quiescent.

We know so little of the embryology of the Myriapods that the aid of development can be had to only a slight extent in our comparisons,but the facts which it affords seem important. In the Chilopods the embryo escapes from the egg with numerous ambulatory appendages, a pair to each somite. The same is true of the typical Hexapods, all later observers agreeing that a polypod precedes a hexapod condition. The young Diplopod escapes from the egg in a Hexapod condition, and the presence of these six legs has been seized upon as a proof of the near association of these forms. An exact comparison, however, seems to show that the two are in reality very unlike as appears in the following table.[10]

[9] Single in Scolopendra.

[10] As nothing is known of the existence of a tritocerebral segment in the Diplopods, the comparison can only be made upon the basis of the appendages of the adult. If the tritocerebral segment should prove lacking in the millepeds, the contrast will prove stronger than it now is. The statement of the Diplopod appendages is based upon Heathcote ('88).

	Hexapoda (+Chilopod).		Diplopod.	
Appendage I	Antenna	Head	Antenna	Head
" II	Mandible		Mandible	
" III	Maxilla 1		Lower Lip	
" IV	Maxilla 2		Foot 1	
" V	Thoracic Foot 1	Thorax	Absent	
" VI	Thoracic Foot 2		Foot 2	
" VII	Thoracic Foot 3		Foot 3	
" VIII	Abdominal Foot 1		Absent	
" IX	Abdominal Foot 2		Absent	

Class I—Chilopoda.

Insecta with elongate depressed body, no differentiation between thorax and abdomen, all the somites being provided with appendages, those of the thorax-abdomen being locomotor in function.

Class II—Hexapoda.

Insecta with body consisting of not over 19 somites, divided into head, three-jointed thorax and abdomen. Thorax provided with three pairs of locomotor appendages, and usually with two pairs of wings; abdominal appendages usually lacking from most somites, those of the extremity being usually modified for reproduction and sensory purposes, those of the other somites, when present, being weak.

Sub-Phylum III—Diplopoda sive Chilognatha.

Elongate, homonomously segmented Arthropods; head distinct, bearing three pairs of appendages; no distinction between thorax and abdomen; this region with numerous somites, all, except the anterior, having two pairs of appendages (double somites), sternum narrow. Stigmata two to each somite, tracheæ tufted and unbranched, not anastomosing. Gonads single, beneath the alimentary canal; spermatoza quiescent; genital ducts opening between the bases of the second and third pairs of feet.

I have given above my reasons for the separation of the Diplopods from the Chilopods, and need not repeat them here. I do not discuss the relations of the Diplopoda to the other sub-phyla, nor the relative position to be accorded the group. The ventral position of the gonads is a mark of low rank, but in other respects the organization is much higher.

ARTHROPODA OF UNCERTAIN POSITION.

I—Pycnogonida sive Pantopoda.

Regarding the systematic position of these forms I cannot add anything to the remarks of Morgan ('90), who has shown that not only in adult structure but in certain features of development, notably in the formation of the entoderm by delamination, they present conditions not easily paralled outside of the Arachnida, and it is not impossible that they may belong there. The appendages are easily homologised in the two groups, and especially interesting is the fact that while most genera in the female retain a primitive condition in having the genital ducts open upon several pairs of appendages (IV–VII), in a few these openings occur only on the seventh appendage, exactly where they occur in the Scorpions.

II—Linguatulina.[11]

These forms, frequently associated with the Arachnids, possess but few points of similarity with them. Chief among these are the concentration of the nervous centres to a circumœsophageal ring, and the peculiar arrangement of the ovarian follicles. On the other hand, neither embryos nor adult resemble any Arachnids in more than a few superficial features. The opening of the genital ducts in the female near the posterior end of the body is not Arachnid in character, nor is the absence of "liver" lobes from the mid-gut. Besides, as non-Arthropodan characters, may be mentioned the extensive cœlom and the outer circular body muscles. The species of Pentastomæ have been so modified by parasitism that it is

[11] Upon points of structure and development consult Stiles ('91) and Spencer ('92), in addition to the older literature.

difficult to say whether the lack of other structures characteristic of Arthropods is due to primitive simplicity or to degeneration.

III—Pauropoda.

The position of the Pauropoda is, as yet, very uncertain, as we are almost entirely ignorant of their internal structure. In the tendency towards a fusion of somites, in the lack of a second pair of maxillæ, and in the positions of the external paired openings of the genital ducts at the base of the second pair of ambulatory appendages and the non-motile spermatozoa they show undoubted affinities with the Diplopoda; but the peculiar triramous antennæ and especially the characters of the hexapod young, as figured by Lubbock ('67) and Ryder ('79) show important differences. The following table compares the somites of Pauropus and the Diplopod:

	Diplopod.	Pauropod.
Appendage I	Antenna	Antenna
" II	Mandible	Mandible
" III	Lower Lip	Lower Lip
" IV	Foot 1	Absent
" V	Absent	Foot 1
" VI	Foot 2	Foot 2
" VII	Foot 3	Foot 3

IV—Tardigrada.

Elongate metameric animals with four pairs of appendages, each terminating with two double hooks. Mouth and anus terminal, Malpighian tubes present, opening into the hind-gut. Nervous system consisting of a supraœsophageal brain and a chain of four ventral ganglia. No specialised circulatory or respiratory organs. No coxal glands or nephridia. Sexes separate, gonad unpaired, emptying into hind-gut.

Most frequently the Tardigrades are associated with the Arachnida, but this has doubtless been due to the possession of four pairs of functional legs in the two groups. These forms

differ from the Arachnids in the absence of all mouth parts,[12] in the proctodeal excretory tubes, the simple nervous system, smooth muscular tissue, and in the absence of nephridia, and they further differ from not only the Arachnids, but from all Arthropods in the fact that the gonads open into the hind-gut.

V—Malacopoda.[13]

The Arthropodan features of the Malacopoda, represented by the single genus Peripatus, are the tracheæ, the legs terminating in claws, the appendicular nature of the jaws, the exclusive use of a pair of nephridia for genital ducts, the reduced cœlom; the several ostia of the heart, the heart being enclosed in a pericardium; the lacunar circulation. On the other hand, the Malacopoda differ from all other Arthropoda and agree with the Annelids in the following particulars:

The presence of functional nephridia in each body segment; the presence of well-developed coxal glands; the existence of an outer circular muscular layer in the body wall; the absence of striation from all muscles except those of the mouth parts; the presence of cilia in the alimentary canal and in the nephridia; the situation of the antennæ as outgrowths from the primitively preoral region; the muscular nature of the pharynx, unlike that of any Arthropod and strikingly that of certain Chætopods. The eyes are too unlike the usual organs of any other Arthropod, but, as figured by Balfour, they closely resemble these organs in Autolytus. There is, too, an absence of a well-developed external cuticular skeleton, so that the absence of a true jointing in the appendages is noticeable. Judging from figures, the terminal claws of the legs might be compared with the setæ of the annelid parapodium.

On the whole, Peripatus cannot be placed beyond question in the Arthropodan phylum, and it is doubtful if it would have been placed there were it not for the presence of tracheæ.

[12] The internal acicular teeth can hardly be regarded as appendages.

[13] I prefer to use the term Malacopoda for this group, because it is the oldest, being given by Blanchard in 1847. Onychophora of Grube dates from 1853, Protracheata was given by Mosely in 1874. The failure of Blanchard to recognize all points of structure does not invalidate his name.

As we have already pointed out the existence of three different kinds of tracheæ which cannot be traced to a common origin, it is barely possible that those of Peripatus and the other "Tracheates" are not strictly homologous.

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ON A SMALL COLLECTION OF VERTEBRATE FOSSILS FROM THE LOUP FORK BEDS OF NORTHWESTERN NEBRASKA; WITH NOTE ON THE GEOLOGY OF THE REGION.

By J. B. Hatcher.[1]

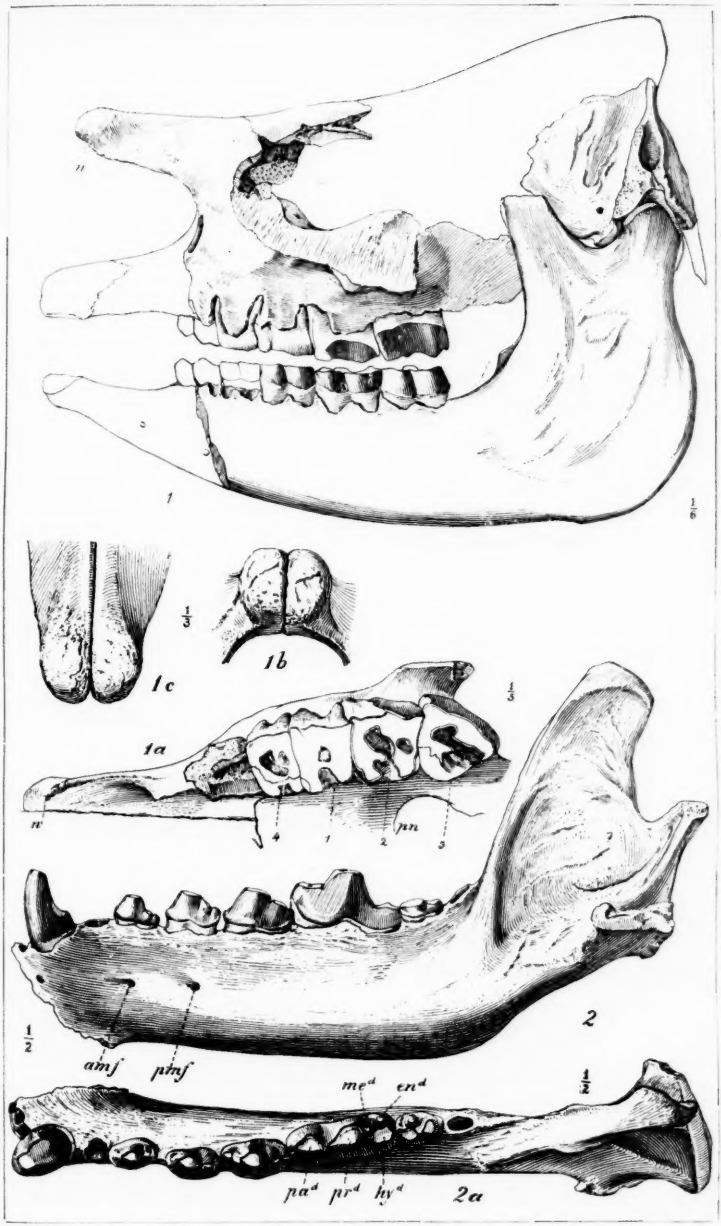
The Princeton Scientific Expedition of 1893, besides securing a quite complete series of fossils from the Protoceras beds of the upper White River, was also fortunate in securing small, but interesting collections from the Loup Fork and overlying Equus beds, and in discovering unconformities between the latter. These unconformities made it possible to distinguish sharply between the top of the Loup Fork and the base of the Equus beds; and consequently to separate the fossils of the one from those of the other with certainty.

The work in the Loup Fork and Equus beds was done by the writer previous to the arrival of the other members of the expedition. The material collected was found in the adjacent hills on the south side of the Niobrara river, midway between the mouths of Pine and Box Butte creeks in Sheridan Co., Nebraska. The material from the Loup Fork beds has been placed in my hands for description through the kindness of Prof. W. B. Scott, under whose direction the expedition was undertaken. It contains, besides several species already fully described from these beds, the following material representing one new genus, and three new species and presenting interesting characters not before noticed in species already known.

AELURODON TAXOIDES, sp. n.

Among the Loup Fork Carnivora, the genus Aelurodon was predominant, both as to individuals and species represented. In size they were propably only equalled among the Carnivora of this epoch by the sabre-toothed cats. In the latter they doubtless found formidable enemies.

[1]Curator of Vertebrate Paleontology of Princeton College.



R. WEBER, DEL.

The type of this species consists of a very complete and well preserved left mandibular ramus. It belonged to an animal about the size of the black bear. The mandible is long and proportionately slender. Posterior depth but little greater than anterior. Masseteric fossa very deep, its anterior border ending directly below the third molar. Anterior mental foramen directly below middle of second premolar. Posterior mental foramen directly below posterior root of third premolar. Surface between anterior margin of masseteric fossa and a point below the middle of the sectorial quite concave. Inferior border nearly straight from synphysis to a point directly beneath the posterior border of the second molar, when it rises quite rapidly to the angle, much as in the badger (*Meles taxus*) thus suggesting the specific name. The angle is considerably expanded transversely for the attachment of the masseter muscle. The exterior border of this expansion is on a line with the base of the teeth. The condyle is strong. The coronoid process is quite high and proportionately somewhat slender. Its upper and anterior borders, especially the latter, are considerably expanded transversely to give greater surface for the attachment of the temporal muscle. The inner border of the ramus is a nearly plane surface, except anteriorly where it is strongly convex. The dental foramen is situated about midway between molar three and the angle, and is on a line with the alveolar border. The symphysis is small and triangular in outline, and is extended somewhat below the inferior border of the jaw. Its supero-inferior diameter is about twice that of the antero-posterior diameter.

The Teeth: The incisors are missing, but they are represented by three somewhat shallow alveoli crowded closely together. The internal and middle incisors were about equal in size and quite small. The latter was crowded considerably backward out of line with the external and internal. The external incisor was considerably larger than incisors one and two. The canine is only moderately strong and is oval in cross-section at the base. The first premolar is missing, but the alveole is well preserved and shows it to have been of moderate size and fixed by one root only. There is a diastema between it and

the canine and a shorter one between it and premolar two. Premolars two, three, and four are strong, well developed teeth, they increase regularly in size and are separated by diastemata. The sectorial is large as compared with molars two and three, its antero-posterior diameter being almost double that of both these teeth taken together. The metaconid is exceedingly faint, the talon is low and flat and consists of both an external and internal cone of which the former alone has been subjected to wear. Molar two is quite small, not so large as premolar two. Molar three is missing but the alveole shows it to have been quite rudimentary and implanted by one root only in the slightly rising alveolar border of the jaw.

The present species appears to be most closely related to *A. uirsinus* Cope and *A. haydenii* Leidy. From the former it is readily distinguished by the nearly uniform depth of the jaw, by the much smaller canine and by the relative and absolute size of the premolar and tubercular teeth. In *A. ursinus* according to Cope[2] the first tubercular considerably exceeds in size the fourth premolar, in *A. taxoides* the fourth premolar is twice the size of the first tubercular. From *A. haydenii* it is at once distinguished by the much less elevated posterior portion of the alveolus, by the somewhat less massive appearance of the jaw and by the diastemata between the premolars. The following are the more important measurements of the type specimen.

	M.
Length of jaw from front of synphysis to middle of condyle	.207
Length of premolar dentition	.062
Length of molar dentition	.053
Antero-posterior diameter of sectorial	.034
Antero-posterior diameter of first tubercular	.012
Antero-posterior diameter of fourth premolar	.022
Depth of ramus below first premolar	.039
Depth of ramus below first tubercular	.040

In Plate I, figures 2 and 2[a] represent the side and crown views of the type and show well the more important charac-

[2]See U. S. Geogr. S, G. M. Wheeler, part II, Vol. IV, p. 304, 1877.

ters. An atlas vertebra found in connection with the type specimen shows a distinct foramen for the inferior branch of the first spinal nerve, but presents no other distinctive characters.

AELURODON MEANDRINUS, sp. n.

This species is by far the largest of the genus yet described. The type consists of the right mandibular ramus, broken off at the canine and just back of the sectorial. It indicates an animal about the size of the grizzly bear. The jaw was exceedingly strong and massive in proportion to its length. The crowns of premolars two and three are preserved and the roots of the sectorial and premolar four. The symphysis is quadrangular in shape and extends backward to below the middle of premolar three, its upper border approaches very closely the alveolar border. The anterior mental foramen is large and is situated just below the posterior root of premolar two. The arrangement of the teeth is especially characteristic and has suggested the specific name. The second, third, and fourth premolars are implanted in the the jaw in a zig-zag manner. The anterior end of premolar three is entirely outside of the posterior root of premolar two. Premolar four is set quite as much transversely as longitudinally in the jaw, its posterior root being as much outside of as behind the anterior. The anterior root of the sectorial is inside of and overlaps the posterior root of premolar four. This arrangement of the teeth is well shown in figs. 1 and 1ª.

The canine was very large as indicated by the alveole which is partially preserved. There was a long diastema between it and premolar one. The latter tooth was small and fixed by one root only. Premolars two and three are small and nearly equal in size. Premolar four is much larger than two and three. All the premolars are separated by very small diastemata. The sectorial is exceedingly large, its antero-posterior diameter equalling in length the space occupied by premolars two, three, and four. In fig. 1 only about half the posterior root of the sectorial is shown, thus making the tooth appear shorter than it really is. The following are the principal measurements of the type.

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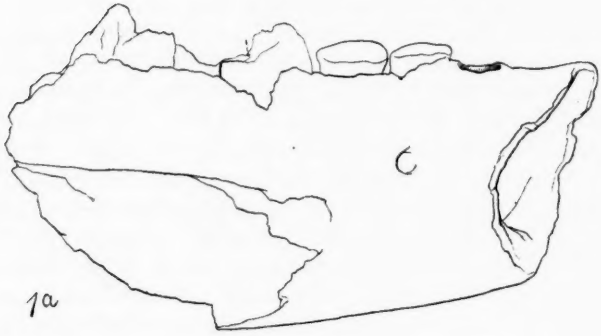
	M.
Length of premolar dentition	.060
Antero-posterior diameter of sectorial	.047
Length of diastema between canine and P. 1.	.019
Depth of ramus below P. 1.	.050
Depth of ramus just behind P. 4.	.055

1



1a

APHELOPS, Cope.

Cope has defined the genus Aphelops as follows.[3] Dentition: I $?\frac{2-1}{1}$, C $\frac{1}{1}$, P $\frac{4-3}{3}$, M $\frac{3}{3}$; post-glenoid and post-tympanic process in contact but not coossified; digits 3–3; nasals hornless. To these characters Osborn[4] has added: "Magnum not supporting lunar anteriorly; absence of the crista and invariable presence of the more or less strongly developed 'crochet' and 'anticrochet' in the superior molars." The projection referred to by Prof. Osborn as the anticrochet is, I think, really the crista, since it is produced quite as much or more from the

[3]Bull. V, U. S. G. S.. 1879–80.

[4]Bull. Mus. Comp. Zool. Harvard, p. 92.

upper border as from the lateral, and moreover, an examination of material in our collection shows in molar one of Aphelops and molor two of Teleoceras an additional small projection directly opposite the large anticrochet, and which I believe to be the crochet and have so lettered it. See Plate II, figs. 5 & 6. I would therefore amend Prof. Osborn's dental characters to read as follows: Invariable presence of strong anticrochet and crista and absence of well defined crochet on superior molars. If this projection is not the crista, it is the crochet instead of the anticrochet, as considered by Osborn.

APHELOPS FOSSIGER, Cope.

I have referred a nearly complete skull in our collection to the above species. It differs from Cope's definition of that species however by the following characters which may perhaps be considered of specific importance. In molar one the the median sinus is obstructed by a large crista and anticrochet and a very small crochet, in molar two there is no trace of a crochet and at the bottom of the entrance of the median sinus there is a small tubercle. In molar three at the bottom of the entrance of the median sinus, there is an elongated tubercle placed transversely, and just inside this is a second much smaller conical tubercle. At about the middle and on the upper border of the zygomata there are processes curving inward and downward which probably served as attachments for the zygomatico-auricularis muscles. The molar teeth also are extremely large. Below are some of the measurements.

	M.
Length of true molars	.168
Median length of second molar	.062
Greatest length of second molar	.075
Greatest width of second molar	.077

TELEOCERAS MAJOR, Hatcher.

As stated in a preliminary notice,[5] this genus is distinguished from all previously known genera of the *Rhinocerida* by

[5]Am. Geol., March, 1894, pp. 149–150.

the presence of a median horn on the extremities of the nasals, the presence of a sagittal crest? as indicated by the contour of the outer walls below this region and the presence of a strong anticrochet and crista and the absence of a well developed crochet on the superior true molars.

The type consists of a portion of the skull and lower jaw. The superior and inferior molars are preserved and also the fourth upper premolar. The skull is long and proportionately much deeper and narrower than in the closely allied genus Aphelops. The nasals are only partially coossified, they are very thick and strong, much compressed anteriorly and strongly convex superiorly. Their extremities are prolonged into a short, stout horn which extends about an inch beyond the extremities of the nasals proper, and is directed upward and forward, it is slightly constricted inferiorly just in front of the termination of the nasals; it is rugose and in life evidently supported a dermal horn. These characters are well shown in Plate I, figs. 1, 1^b, 1^c, 1^d. The frontals are comparatively narrow and smooth, and their upper transverse surface is gently convex, they are elevated posteriorly so that the median line from the posterior portion of the frontals to the end of the nasal horn is slightly concave. The infra-orbital foramen is large, opens anteriorly and not laterally directly over the middle of premolar three. The maxillaries are large, strong and deep. The anterior border of the posterior nares is on a line with the posterior border of the median sinus of molar two, there is no median projection. The temporal region is much constricted, the inferior lateral walls of the brain case in this region are exceedingly thin, there were no air cavities in this region of the skull. The base of the skull sloped upward and forward from the condyles which are missing. The post-glenoid process is strong and triangular in cross-section, it is confluent *but not coossified* with the post-tympanic throughout the greater portion of their length, thus entirely enclosing the *meatus auditorius externus.*

The lower jaw is exceedingly strong and massive. The ascending portion is very high and broad with the posterior border but slightly expanded transversely. The masseteric

fossa is very shallow. The inferior dental foramen is large. The coronoid process is wide at the base and narrows rapidly toward the apex. The angle is produced but slightly downward. The inferior border is gently convex.

The Teeth: Of the superior dentition the true molars and the fourth upper premolar alone are represented. They are larger than in the recent rhinoceros but much smaller than in *Aphelops* as shown in Plate II, figs. 5, 6, & 9. Molars two and three are best preserved and present the most distinctive characters. The dorsum is very flat, there is no median costa and the anterior and posterior costae are only faintly represented On the posterior angle of molar three there is a well developed basal cingulum. The median sinus of this tooth is obstructed by a well developed anticrochet and crista. At the bottom and near the entrance of the median sinus is a small tubercle. Molar two has a faint crochet directly opposite the strong anticrochet and a well developed crista as shown in Plate II, fig. 6. There was a deep posterior sinus with a strong posterior vallum which in the type has been worn down so that the posterior sinus now appears as a posterior fossette. There is a very small anterior sinus and the anterior vallum is weak. In molar one and premolar four the teeth are so much worn that the anterior and posterior cross-crests are united through the anticrochet, and the inner portion of the median sinus appears as an accessory fossette.

In the inferior dentition the last molar is placed well in front of the ascending portion of the ramus, it is but little larger than molars one and two, and has a basal cingulum on the posterior border. The following are the principal measurements of the skull, lower jaw, and teeth.

SKULL AND SUPERIOR DENTITION.

	M.
Length of skull from end of nasal horn to behind post-tympanic process	.585
Depth of skull from middle of frontals to crown of teeth	.235
Width of skull in front of zygoma	.210

Length of horn beyond termination of nasals	.028
Diameter of horn	.041
Length of molar dentition	.158
Greatest transverse diameter of molar two	.069
Greatest antero-posterior diameter of molar two	.055

LOWER JAW AND TEETH.

	M.
Length of ramus from anterior border of premolar four to posterior border	.420
Height from bottom of angle to condyle	.260
Depth below molar three	.109
Length of molar dentition	.155
Length of molar two	.054
Length of molar three	.058

Teleoceras although presenting several characters apparently intermediate between Aphelops and existing genera of Rhinoceridæ, nevertheless cannot be considered as an ancestor of the latter. Neither is it a migrant from Europe. It is really a horned Aphelops derived perhaps through Leidy's species *A. crassus;* which latter is not unlikely to be identical with *A. fossiger* (Cope) and *A. acutum* (Marsh), all of which have been described as possessing compressed, acuminate nasals, thus suggesting a horn at the very place where it appears in *Teleoceras.*

The discovery of a *median horned Rhinoceras* in America is of interest not as a probable ancestor of existing Old World forms, but rather as exhibiting a remarkable example of *parallelism* in the development of the Old and New World species of Rhinoceridæ from their common ancestral genus Aceratherium of the lower Miocene of this continent. Our present knowledge would indicate, as has been pointed out by Scott,[6] that the ancestral type originated in America and found its way into the Old World in early Miocene times. The genus Aceratherium which flourished during the lower Miocene was common to both continents, and all the median horned

[6]See Bull. 3, E. M. Museum, Princ. Coll., pp. 1–22, 1883.

and hornless forms of each continent may reasonably be considered to have been developed independently from it. There seems at present no evidence for supposing that there was any interchange of species between the two continents later than early Miocene times. This degree of parallelism is all the more striking when we consider the length of the period of isolation in connection with the marked degree of similarity shown. This similarity is exhibited not only in the development of a nasal horn, but also in the general appearance of the skull, the complexity of the structure of the teeth and their arrangement in the jaw, and the relations of the post-tympanic and post-glenoid processes, Figs. I–4, Plate II, show the latter in the genera Rhinoceros, Teleoceras, Aphelops and Ceratorhinus. On the same plate, figs. 5, 6, 7, 8 & 9 represent various stages of tooth development from Aceratherium to Teleoceras and recent forms. As regards specialization of parts and complexity of tooth structure, from what is at present known of Teleoceras, it may be regarded as equalling in these respects any of our recent forms. If we compare it with *Rhinoceros sansaniensis* (Lartet) from a horizon in France of which our Loup Fork has been considered an equivalent, it will at once be seen that the tooth structure of the latter is much simpler and more like Aceratherium. See Plate II, fig. 7 (after Filhol). If these beds be really of the same age we must conclude that the conditions favorable for the development of the more modern types of the Rhinoceridæ, existed to a much greater degree in America than in Europe, a condition of affairs not improbable when we reflect that the family was originated on this continent.

Technically, perhaps, Teleoceras should not be considered as generically distinguishable from Rhinoceros, and had it been found in Europe it would doubtless have been referred to that genus. Since however it is an American form, found in the same beds with Aphelops, its unmistakable ancestor, which latter as has been shown by Cope, Scott and Osborn, is quite distinct from Rhinoceros, I have decided to refer it to a distinct genus; believing that classification should rest so far as possible upon our knowledge of actual relations, and should

be an expression of those relations so far as they are understood and not a mere set of conveniences, based entirely upon the presence or absence, and similarity or dissimilarity of parts.

GEOLOGY OF THE REGION.

In the immediate region in which the collections were made, only two distinct geological horizons appear on the surface, these are the Loup Fork and Equus beds. None of the water courses have here succeeded in entirely removing the Loup Fork, and exposing the underlying older strata. The Loup Fork beds consists of light colored, calcareous sandstones, somewhat loosely cemented, resembling in color and friability, old mortar. They are everywhere penetrated by numerous calcareous rods or tubes, probably the casts of root-stocks of aquatic plants. They dip very gently to the southeast which is evidenced by the fact that the southern slopes are gentle, while those looking northward are abrupt. Where they have not been entirely removed by erosion, the Equus beds unconformably overlie the Loup Fork beds. This unconformity has been overlooked by all previous explorations in this region. Marsh makes no mention of it in reporting on his expedition into this very place in 1872; and in his subsequent descriptions of vertebrate fossils from these beds, he has not distinguished between them, although their respective faunas are really quite distinct, and the beds themselves are not the result of a continuous sedimentation from the commencement of the one to the close of the other; but there was an important break at the close of the Loup Fork when this region became dry land, and remained such through a long period of time, after which the Equus beds were deposited upon the eroded surface of the Loup Fork.

The Equus beds are composed of loose, incoherent sands, except for occasional layers of somewhat tough, gritty clays. The rapidity with which they yield to erosion, and their generally incoherent nature has greatly aided in concealing their exact statigraphic relations to the underlying beds. In

almost all exposures the exact contact is concealed by a *talus* from the upper beds. In several instances, however, the true relations were easily determined and one, which presented particularly favorable conditions is represented here in fig. 2. It represents a short section of the east side of one of the main 'draws' emptying into the Niobrara river. At this point this small water course has cut directly across the bed of a similar water course eroded out of the surface of the Loup Fork and since filled by the Equus beds. At this same point there enters the main 'draw' a small tributary from the east, and the combined currents of these two water courses, although

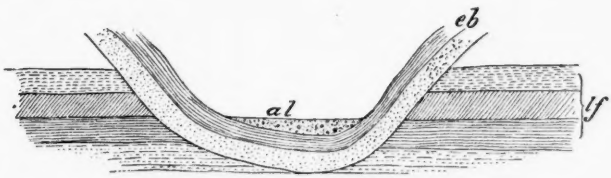


FIG. 2.

entirely dry except immediately after heavy rains, have sufficed to keep the actual contact apparent. At lf. appear the nearly horizontal Loup Fork strata with their characteristic fossils, *Aphelops*, *Aelurodon*, *Procamelus*, *Protohippus*, *Mastodon*, etc. At eb. the Equus beds are seen resting unconformably upon the Loup Fork beds at an angle of about 15° and containing fossils characteristic of these beds, *Equus*, *Elephas*, *Mylodon*, *Canis*, etc.; al. represents the recent deposits in the bottom of the "draws," all below the top of this line is imaginary. On the opposite side of the main draw the same conditions are seen at the bottom, but toward the top the contact is not so apparent, since there is on this side no tributary to aid in keeping the exposure free from talus.

The figures in the plates and the text accompanying this paper were executed by Mr. Rudolph Weber. To the various members of the expedition, whose liberality made it possible, the authors best thanks are especially due.

Explanation of Plates.

Plate I.

Fig. 1. Side view of *Teleoceras major*, n. end of nasals.
1ª. Bottom view of *Teleoceras major*, n. end of nasals, pn. posterior nares.
1 . Front view of nasal horn of same.
1ᶜ. Top view of nasal horn of same.
Fig. 2. Side view of lower jaw of *Aelurodon taxoides*, amf. anterior mental foramen, pmf. posterior mental formen.
2ª. Crown view of same; pa^d, paraconid, pr^d. protoconid, hy^d. hypoconid, me^d. metaconid, en^d. entoconid.

Plate II.

Fig. 1. Side view of temporal region of *Rhinoceros sondaicus* (after Flower), mae. meatus auditorius externus, pg. post-glenoid process, pt. post-tympanic process.
Fig. 2. Side view of temporal region of *Teleoceras major*.
Fig. 3. Side view of temporal region of *Aphelops fossiger*.
Fig. 4. Side view of temporal region of *Ceratorhinus sumatrensis*.
Fig. 5. Second, left upper molar of *Aphelops fossiger?* crs. crista, acr. anticrochet, ps. posterior sinus.
Fig. 6. Second, left upper molar of *Teleoceras major*, crs. crista, acr. anticrochet, cr. crochet, ms. median sinus, as. anterior sinus, pf. posterior fossette.
Fig. 7. Second, left upper molar of *Rhinoceras sansaniensis* (after Filhol), ps. posterior sinus, pv. posterior vallum.
Fig. 8. Second, left upper molar of *Aceratherium occidentale?* letters as in fig. 6.
Fig. 9. Second, left upper molar of *Ceratorhinus sumatrensis*, cr. crochet, pv. posterior vallum.

EDITORIALS.

—THE postoffice department at Washington adopted last year a new style of letter box for cities, which has generally replaced the old ones. This change has been for the worse in one important respect. While the boxes of the new pattern afford better protection from thieves, they are unfit for the reception of second and third class matter generally. The opening is too small, and the fore and aft diameter is too narrow to receive the greater part of such matter. In the attempt to use these boxes for such matter, it is apt to be injured, but usually it cannot be inserted. As the new boxes were not, we learn, intended to exclude such matter, they show a lack of intelligence on the part of both the designer and the department. The old boxes are much more useful, but a new box of the modern pattern, with a wider gape and deeper throat, would be better still. Editors and publishers would be much accommodated by such a change. This would be an improvement much more important than most of the novelties introduced by the last administration of the postoffice department.

—THE International Congress of Zoologists of 1892, was held at Moscow, and was an occasion of much interest. Many important papers were read, a majority of them naturally having reference to various parts of the vast territory under the dominion of the Czar. A peculiar feature of the volume issued by the Congress, which embraces the papers read or abstracts of them, is that it contains a full page portrait of the Grand Duke Serge Alexandrowitch in military costume, as a frontispiece. Below the portrait is a fulsome expressiom of "veneration and thanks" for aid rendered the Congress by "his imperial highness." This strikes us as strangely out of place in a zoölogical work, and not less so because the Congress was "international." The singing of the Russian national hymn, with which the last session of the Congress was closed, can hardly be regarded as an "international" zoölogical ceremony.

—THE conduct of the authorities of the Chicago Exposition since its close, has not been characterized by that care for the property of the exhibitors and others necessarily under their charge, which should characterize an honorable corporation. The buildings have been left insufficiently guarded, and tramps have had full opportunity to perpetrate mischief. Among these, incendiary fires have been conspicuous,

so that damage has been done to the property of exhibitors, and many narrow escapes have been made. The dismantelment of the fire apparatus has rendered the situation all the more dangerous. Finally the quarters for the shelter of the strangers engaged in moving their exhibits have been rendered uninhabitable at an inclement season of the year. Altogether, the hospitality of Chicago to exhibitors and national commissions has been scanty, and this part of the exposition management does not redound to the credit of the city. It is in marked contrast to that which has characterized the expositions held elsewhere in both Europe and America.

—THE closing of the Allis Biological Laboratory at Milwaukee, is much to be regretted, but as it is due to the financial stringency, it is to be hoped that, with the return of more prosperous times, it will be reopened by its public-spirited and scientific founder.

RECENT BOOKS AND PAMPHLETS.

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CARUS, P.—The Philosophy of the Tool. Chicago, 1893.

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CHAPMAN, H. C.—Observations on the Japanese Salamander. Extr. Proceeds. Phila. Acad. Nat. Sci., 1893. From the author.

CHAPMAN, H. C., AND BRUBAKER, A. P.—The Radius of Curvature of the Cornea. Extr. Proceeds Acad. Nat. Sci., Phila., 1893. From the author.

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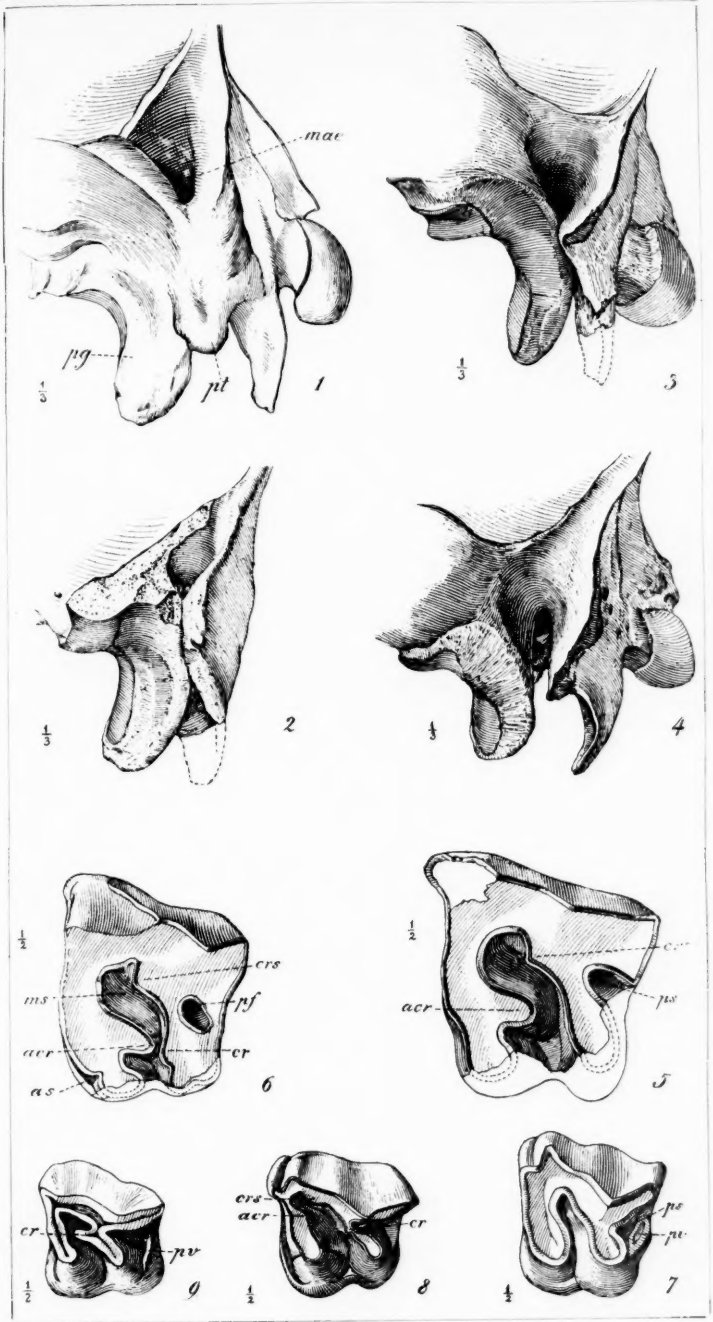
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RECENT LITERATURE.

The Canadian Ice Age.[1]—This volume, an octavo of 300 pages, is a compilation of observations bearing upon the history of the northern half of the North American Continent during the Ice Age, recorded by Sir Wm. Dawson since 1855. The generalizations are not extended beyond the Canadian border, but the author's conclusions deny the possibility of large accumulations of land ice on an interior continental plain, south as well as north of the Canadian boundary. In fact, at that time, according to the author, there was no interior plain. An ideal map of Canada during the Plistocene Age, shows the northern half of the continent to consist of three large mountainous islands, the Cordilleran, the Laurentide, and the Appalachian, with Greenland to the north, surrounded by ice ladened seas and straights. These islands were the gathering-grounds of the snow and ice that, in the form of glaciers and icebergs, were such powerful agents in modifying the topography of the continent. The ice movement on these islands appeared to be outward in all directions from a central axis or plateau, analagous to what is taking place in Greenland at the present day. The "Terminal Moraine" of the glacialists represents the shore line of the ice-ladened sea where floe-ice and bergs grounded with their burden of boulders and other débris. Anomalies in the levels of the so-called terminal moraine are due to differential elevation. The author gives a résumé of the the present knowledge of the glacial movements during the Plistocene period, as shown by the striae, and the conditions under which the Boulder-drift of Canada was deposited as proofs of the above theory.

The succession of deposits is treated of at length, and the subject is summarized in tables of succession and correlation. In an ascending order the strata are (1) a lower boulder clay or till resting on heavily striated rock surface, representing shallow water deposit; (2) Leda clay, the greater part of which, from the evidence of its fossil contents, was laid down in water from 20 to 100 fathoms deep; (3) surface boulders.

In regard to the striae, the author makes the following general statement as to the agents producing them:

[1] The Canadian Ice Age. Being Notes on the Plistocene Geology of Canada, with especial reference to the Life of the Period and its Climatal Conditions, and lists of the specimens in the Museum. By Sir J. Wm. Dawson. Montreal, 1893.

"In summing up this subject, it may be affirmed that when the striation and transfer of materials have obviously been from N. E. to S. W., in the direction of the Arctic current, and more especially when marine remains occur in the drift, we may infer that floating ice and marine currents have been the efficient agents. Where the striation has a local character, depending upon existing mountains and valleys, we may infer the action of land ice. For many minor effects of striation, and of heaping up of moraine-like ridges, we may refer to the presence of lake or coast ice as the land was rising or subsiding."

Again, "Sea glaciation is always accompanied with much smoothing and polishing, and on very hard rocks the striation is comparatively imperfect, while it is not quite uniform in direction and often presents two sets of striae. The action of true land glaciers, especially when moving down considerable slopes, produces deep grooves, as well as striae, on vertical as well as on horizontal surfaces, and is more fixed and uniform."

The summary of fossils given in Chapter VI, comprises 240 species, of which 33 are plants; the rest are distributed as follows: Protozoa, 21; Echinodermata, 7; Mollusca, 142; Vermes and Arthropoda, 30; Vertebrata, 7. From both flora and fauna the author infers an amelioration of the climate, resulting, in his estimation, from the gradual elevation of the land which threw the Arctic currents from its surface, exposed a larger area to the direct action of solar heat, and probably determined the flow of marine currents so that the heavy northern ice was led out into the Atlantic instead of being drifted southwest over the lower levels of the continent.

The leading thoughts in this collection of papers is the relative value of land ice and water-borne ice as causes of geological change during the Plistocene period. These two agents, together with the complex elevations and depressions of the continent as shown by the deposits and their fossil contents account for the effects observed.

This paper is an important one, and will probably correct the extravagancies into which the past glacialists have faller.

The Mollusc-Fauna of the Galapagos Islands.[2]—The molluscan forms collected by Professor Leslie A. Lee and his assistants, on the voyage of the U. S. Fish Commission Steamer Albatross, from

[2] Scientific Results of Explorations by the U. S. Fish Commission Steamer Albatross. No. XXV. Report on the Mollusk-fauna of the Galapagos Islands, with Descriptions of New Species. By Robert E. C. Stearns, Ph. D. Adjunct Curator of the Department of Mollusks. Proc. U. S. Nat. Mus., Vol. XVI, (1893) pp. 353-450, with plate and map.

Chesapeake Bay by the way of the Strait of Magellan to San Francisco in 1887–88, is the basis of this paper which is, as will be seen in the foot-note, a report on the Galapagos material belonging to this division of the animal kingdom. As the author states in the text, it "refers, so far as the marine molluscs are concerned, with a few exceptions, to the littoral and shallow-water species only." The deep sea material remains to be investigated and reported on hereafter, though a few species described by Dall are included in the list, in the later part of the report.

The geographical and physical characteristics of the islands, their climatology and floral aspect, the distances and depths of the water between them, their origin, and the views of Darwin, Hooker, Wallace, Agassiz, Baur, etc., hereon are briefly presented. The origin of the fauna and the flora is discussed, and in this connection the distribution of terrestrial and marine forms, etc., by oceanic currents, drift lodgement, freshets, and the agency of rivers, and the aerial distribution of animal and plant life, as well as the generative capacity and vitality of land snails, their ability to exist a long time without food, of which numerous instances are given, and the tenacity of life in many species that have been observed, are all referred to and treated at considerable length.

The author favors the *volcanic theory* of the region of these islands as held by the majority of scientific writers, rather than that of Dr. Baur and Milne-Edwards, who regard the Galapagos as "*Continental Islands originated through subsidence,*" a conclusion based principally on biological evidence, etc.. as exhibited in their peculiar fauna and flora.

The number of molluscan species and varieties obtained by the Albatross collectors was 120, of, these 7 species and 9 varieties were terrestrial forms. Four new species are described, and one of these is a land shell, *Bulimulus* (*Pleuropyrgus*) *habelii*; the others are *Onchidium lesliei*, *Nitidella incerta*, and *Tectarius galapagoensis*.

As a part of the report, the late Dr. Philip Carpenter's list of the Galapagos species contained in Reeve's Monograph's is given, also Albers' list of Galapagos *Bulimi;* the Petrel-Cookson shells, as determined by E. A. Smith of the British Museum; Wimmer's list of Habel's collection; Ancey's species, and Reibisch's list of species collected by Dr. Theodor Wolf, State Geologist of Ecuador; Dr. W. H. Jones' Chatham Island shells, Dall's recently described Galapagos species, including a few deep water forms, a part of the Albatross dredgings, and a few land species collected by Dr. Baur.

Following the above the author has added a systematic list, summarized from the preceeding authorities. This compilation, which will be found very convenient by the student, shows a total of 318 species and varieties; of these 48 species and varieties are terrestrial and the others marine. Of the latter, 61 are Lambellibranchs and 1 Scaphopod; 205 species and 13 varieties are Gastropods.

Of the marine species the author says, "Less than a half score are indigenous, of these, some, if not all, may prove, upon a better knowledge of the molluscs of the shores of Central and South America, to belong to the mainland." A comparison is suggested of *Omphalius cooksonii* Smith, with the Antillean *O. fasciatus*. The number of species that exhibit intimate relationship with Antillean-Carribean forms is quite small and in conspicuous when placed side by side with the American types; the latter include nearly all the species contained in the summarized list.

The author observes that the land shells are of a distinctly West South American aspect, and a comparison is suggested with several species named, which occur in Bolivia, Peru and Chili, rather than to the peculiar forms inhabiting Ecuador and other South and Central American States further north.

In several instances the erroneous determination of marine species or varieties of the same, that have been made by various authors resulting in the accrediting of Indo-Pacific forms to the Galapagos Islands, have been pointed out and explained. The report closes with a plate containing figures of the species described, and the map of the Galapagos islands.—CHAS. T. SIMPSON.

An Examination of Weismannism.[3]—The several chapters comprised in this volume have been written at successive intervals during the last six or eight years, as Professor Weismann's works have appeared, so that this discussion by Mr. Romanes presents a clear view of the growth of the Weismannian theories. Three chapters are devoted respectively to Weismann's system up to the year 1886—to the year 1892—to the year 1893. Of the two remaining chapters, one is a discussion of Weismann's theory of heredity (1891), the other is a critical examination of Weismann's theory of evolution (1891). Two appendices entitled "On Germ Plasm and On Telegony" complete the volume.

In conclusion, the author refers to the fundamental changes which Professor Weismann has wrought in his general system of theories by

[3] An Examination of Weismannism. By George John Romanes, M. A., LL. D., F. R. S. Chicago, 1893. Open Court Publishing Co.

the publication of his more recent works, and closes with the following remarks:

"Thus, the Weismannian theory of evolution has entirely fallen to pieces with the removal of its fundamental postulate—the absolute stability of germ-plasm. It only remains to mention once more the effects of this removal upon the other side of his system, viz., the companion postulate of the uninterrupted continuity of germ-plasm, with its superstructure in his theory of heredity."

Briefly, these effects are as follows:

"1. Germ-plasm ceases to be continuous in the sense of having borne a perpetual record of congenital variations from the first origin of sexual propagation.

"2. On the contrary, as all such variations have been originated by the direct action of external conditions, the continuity of germ-plasm in this sense has been interrupted at the commencement of every inherited change during the phylogeny of all plants and animals, unicellular as well as multicellular."

"3. But germ-plasm remains continuous in the restricted, though still highly important sense, of being the sole repository of hereditary characters of each successive generation, so that acquired characters can never have been transmitted to progeny "representatively," even although they have frequently caused those "specialized" changes in the structure of germ-plasm which, as we have seen, must certainly have been of considerable importance in the history of organic evolution."

"4. By surrendering his doctrine of the *absolute* stability of germ-plasm on the one hand, and of its *perpetual* continuity on the other, Weismann has greatly improved his theory of heredity. For, whatever may be thought of his recent additions to this theory in the way of elaborate speculation touching the ultimate mechanism of heredity, it is a great gain to have freed his fundamental postulate of the continuity of germ-plasm from the two further postulates which have just been mentioned, and the sole purpose of which was to provide a basis for his untenable theory of evolution."

"5. In my opinion, it only remains for him to withdraw the last remnant of his theory of evolution by cancelling his modified and even less tenable views on amphimixis, in order to give us a theory of heredity which is at once logically intact and biologically probable."

"6. The theory of germ-plasm would then resemble that of stirp in all points of fundamental importance, save that while the latter leaves open the question as to whether acquired characters are ever inherited in any degree, the former would dogmatically close it, chiefly on the

grounds which I have considered in Appendix II. It seems to me that in the present state of our knowledge, it is more prudent to follow Galton in suspending our judgment with regard to this question, until time shall have been allowed for answering it by the inductive methods of observation and experiment."

"7. Hence, in conclusion, we have for the present, only to repeat what Weismann himself has said in one of the wisest of his utterances: 'The question as to the inheritance of acquired characters remains, whether the theory of germ-plasm be accepted or rejected.'"

"It is now close upon twenty years that I have accepted the substance of this theory under the name of stirp; and since that time the question as to the inheritance of acquired characters remains exactly where it was. No new facts, and no new considerations of much importance, have been forthcoming to assist us in answering it. Therefore, as already stated in the preface, I intend to deal with this question hereafter as a question of *per se*, or one which is not specially associated with the labors of Professor Weismann."

The theory entitled by Romanes by the name of "stirp," was tentatively suggested by Galton in 1875, and was more distinctly enunciated in the AMERICAN NATURALIST for 1889, under the head of Diplogenesis. An acceptance of it is to be found in the article by vom Rath which is republished in the January NATURALIST. It is evident that the diversity in the views of biologists as to the inheritance of acquired characters is becoming more verbal than real.

Extinct Monsters.[1]—In this book of some 250 pages Mr. Hutchinson has endeavored to give a popular account of some of the larger forms of extinct animals, and has illustrated the several chapters with drawings of restorations of them. These drawings are commended to the public by Dr. Henry Woodward, who pronounces them, in a preface, "the happiest set of restorations that has yet appeared."

The author devotes seven of the sixteen chapters to the Saurians, drawing upon the discoveries in the United States for much of his material. Under the head of Sea-Scorpions many points of interest concerning Pterygotus and its allies are given. American Mammals are represented by one species from the Eocene, one from the Neocene, and one from the Plistocene. From the varied Sivalik fauna of India, the author chooses Sivatherium and *Testudo atlas*, and from South America the characteristic Sloths and Glyptodons. The remaining

[1] Extinct Monsters. A Popular Account of Some of the Larger Forms of Ancient Animal Life. By Rev. H. N. Hutchinson, with illustrations by J. Smit. London, 1893, Chapman and Hall, Publishers.

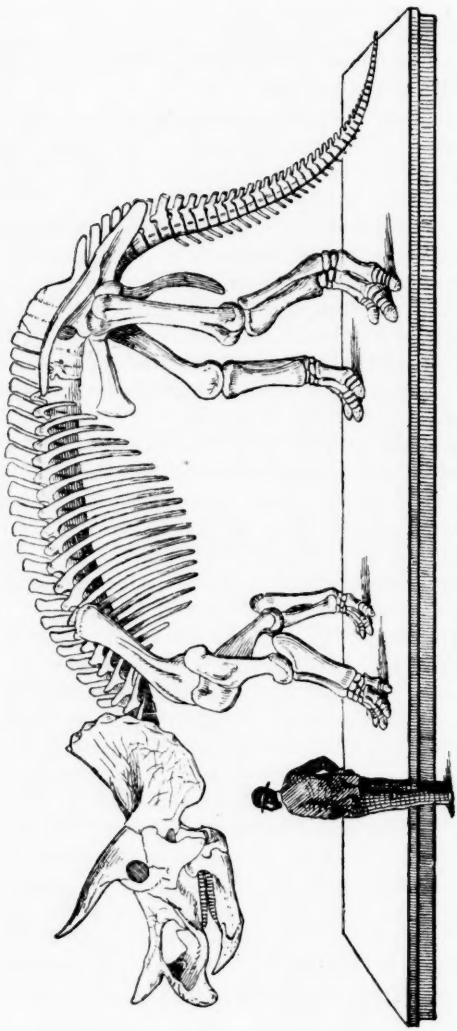

FIG. 1. *Agathaumas fabellatus.* Skeleton. From Marsh.
From the Laramie of N. America.

FIG. 2. Camarasaurus, from the Juarssic of North America.

chapters describe the Mammoth, the Mastodon and the Wooly Rhinoceros, Some Giant Birds, the Irish Elk and Steller's Sea-Cow.

In the appendices reference is made to the recent discoveries by Dr. Fraas of the structure of the dorsal and tail fins of *Ichthyosaurus tenuirostris*, and to Mr. Henry Lee's discussion as to the existence of the great Sea-Serpent. Here also is given a list of British localities where mammoth remains have been found.

The book is written in an entertaining style, and it is likely to interest the lay reader in the subject. That it will have considerable effect in extending a knowledge of the extinct forms of animal life there can be no doubt. Meanwhile it is a pity that the author did not consult some one familiar with the subject, who could have given him the correct nomenclature of some of the forms which he portrays. Thus the so-called Stegosaurus was previously named Hypsirhophus; and paleontologists who have seen both, allege that the name Brontosaurus was given to the reptile previously named Camarasaurus. It is probable that Triceratops is Agathaumas, which was named and described fourteen years before the former name was given. It would have been better to have given a restoration of the *Loxolophodon mirabile* Marsh, rather than one of the *L. ingens;* since a skeleton of the former is known, while none of the latter had been obtained at the time the so-called restoration was made. We understand that a second volume is in preparation, which will contain other forms not included in the one under review. There is a fine field yet open in this direction, and we hope that Mr. Hutchinson will be able to take advantage of it. We owe to the courtesy of the publishers the opportunity of presenting two of the illustrations.

General Notes.

GEOLOGY AND PALEONTOLOGY.

Trans-Pecos Texas.—The studies of Mr. Streeruwitz in western Texas have developed some interesting facts from both a scientific and economic standpoint. The rocks are mostly older and newer eruptives and various metamorphics; the sedimentary, as now known, reach from the Silurian to the Cretaceous period, and Cenozoic deposits are probable. The petrography of the Igneous rocks has been reported upon by Mr. A. Osann in the Ann. Rept. for 1892, Geological Survey of Texas. The results of his examinations show the great diversity of the character of the rocks prevailing in the different mountain ranges and the great difference in time and conditions of their origin.

Mr. Streeruwitz finds that the disintegration of the rocks in Trans-Pecos Texas is mostly the result of the rapid changes of temperature and deflation, the same forces active in the desert of Sahara. The rains are also the cause of another source of disintegration causing that peculiar shape of granite blocks peculiar to the Sahara called "Pilzfelsen." Chemical action manifests itself in the formation of rows of caves in the stratified granular rocks similar again to the African deserts.

The prevalence of ozone in West Texas is explained by the author as the result of the friction of the drifting sand grains among themselves and along the surface of the soil and the rocks, which creates sufficient electricity to ozonize the oxygen of the atmosphere.

In regard to the ores, Mr. Streeruwitz reports that the most of the mountain ranges of Trans-Pecos Texas are ore-bearing. These ores are of excellent quality and exist in paying quantities, along with building stones and material for art and decorative work, not to mention agates, sardonyx, opals and other precious stones. The difficulties in the way of mining these products are pointed out and ways of surmounting them suggested by the writer. Under existing conditions the mountain land of this region is practically valueless, and for lack of irrigation the flats are becoming less fertile from year to year. (Fourth Ann. Rept., 1892, Geol. Surv. Texas, Austin, 1893.)

Estimates of the Duration of the Glacial Epoch.—At a recent meeting of the Geological Society of America, Mr. Warren Upham

showed by a comparison of the shore erosion and accumulation of beach gravel and sand by the waves of Lake Agassiz with those of Lake Michigan that the existence of the former might be estimated at not more than 1000 years; the moraines belonging to the area of the later drift were probably formed in twice that time; the recession of the ice from its outermost limit to the first of these moraines a similar length of time, or perhaps, longer. In these conclusions the author agrees with Prestwich, who estimates the epoch of extreme cold at 15,000 to 25,000 years, and the melting of the ice-sheet to from 8,000 to 10,000 years or less.

In order to show that his conclusion as to the age of Lake Agassiz is consistent with the known records and inferred conditions of the Ice age upon the central belt of the North American continent, Mr. Upham reviews the series of formations in the Mississippi and Nelson river basins which belong to the times immediately preceding, during and following the Glacial period, especially considering the changes in the altitude and slopes of the land and the probable measures of time demanded by the processes of drift transportation and deposition, by subsequent weathering with soil formation, and stream erosion. As a result of his investigations, he gives the following estimates of the duration of the three parts of the Cenozoic period under study, arranged in chronological order:

"The time of preglacial epeirogenic elevation, with the deposition and erosion of the Lafayette beds, some 60,000 to 120,000 years; the Glacial period, regarded as continuous, without interglacial epochs, attending the culmination of the uplift, but terminating after the subsidence of the glaciated region, 20,000 to 30,000 years, and the Postglacial or recent period, extending to the present time, 6000 to 10,000 years. In total the Plistocene era in North America, therefore, has comprised probably about 100,000 or 150,000 years, its latest third or fourth part being the Ice age and subsequent time. The pre-plistocenic Cenozoic era appears by changes of its marine molluscan faunas to have been vastly longer, having comprised, perhaps, between two and four million years, of which the Pliocene period would be a sixth or eighth part, thus exceeding the whole of the ensuing era of great epeirogenic movements and resulting glaciation."

In the discussion which followed the reading of Mr. Upham's paper, Mr. McGee called attention to the unmistakable unconformity between the Columbia and Lafayette formations in the Coastal plain series. This unconformity represents erosion approaching 1000 feet in depth in the Lower Mississippi region and from 300 to 500 or more feet in depth in

the embouchures of the other rivers of the Coastal plain. It is represented not only by the removal of fully one-half of the original volume of the Lafayette formation, but by the degradation of an equal or greater volume of subjacent formations of Neocene, Eocene and Cretaceous age beneath. (Bull. Geol. Soc. Am., Vol. 5, 1894.)

In a previous publication in the same periodical, Mr. Upham had concluded that the observed volume of the Plistocene glacial erosion and resulting drift had probably accumulated in from 10,000 to 20,000 years. In the general conclusion of a short rather than a long period, Mr. R. S. Tarr agrees, but cannot accept Mr. Upham's line of argument, with our present knowledge of the rate of glacial erosion. Various complex factors make a time estimate of little value. Mr. Tarr bases his estimate on the following conditions.

A glacier is supplied with material for erosive work in three ways: (1) it may carry along the loose material in its path; (2) it may rend rocks asunder whenever a place of entry is found; (3) it may obtain material from the rock itself by scouring it with cutting tools already supplied. The erosive action of ice is to round, smooth and polish the surface over which it moves, lessening the possibility of obtaining a supply of cutting tools, so that as the period of ice occupancy lengthens the power of erosion diminishes.

With these facts as a basis, a young glaciated region should be littered with glacial drift, the products of disintegration. In a later stage the deposits would be composed of fresher rock fragments distributed in greatest abundance near the periphery of the ice-sheet. During old age the country would be free from deposits and the topography would consist of polished, rounded hills of glacial erosion. The first stage would be brief, the second longer, and the passage to extreme old age one of slow development.

In accordance with these facts, Mr. Tarr concludes that the North American glaciated region is topographically young, or at most not far advanced into maturity. (Am. Geol., Vol. XII. 1893.)

Geology of Marthas Vineyard.—After a personal investigation of the geology of Marthas Vineyard, Mr. Hollick finds that the ridge of hills consisting of a superstructure of contorted clay strata capped and flanked to the north with till, is composed of material derived from cretaceous and post-cretaceous strata. He does not agree with Shaler that the dislocations and elevations of the strata are due to mountain-building forces, but that they can be accounted for by the same theory that the author advanced for the modification of the strata

of Long Island and Staten Island which is to the south of former cretaceous areas, viz., that the clays have been eroded and ploughed up in masses, and the strata folded or squeezed up and shoved ahead by an advancing ice-sheet, which, upon melting, left them as hills or ridges of dislocated, contorted material covered by the englacial and super-glacial till. (Trans. N. Y., Acad. Sci., XIII, 1894.)

Plistocene Birds of Madagascar.—An important collection of bird bones from Madagascar has been received by the Academie des Sciences de Paris. According to MM. Milne-Edwards and Grandidier these bones indicate that at a period not remote, certaintly contemporary with man, Madagascar was inhabited by 12 species, at least, of gigantic birds, incapable of flight, but provided with immense feet. Two types are distinguished: the first, Æpyornis, comprising 8 or 9 species; the second, named by the author Mullerornis, characterized by a lighter body, and a shorter tail than the first, comprises but 3 species. The conditions under which these bones were found shows that the bird lived on the shores of water, with troups of small hippopotami, crocodiles and turtles. (Revue Scientifique, Jan., 1894.)

Antennæ in Trilobites.—In the American Journal of Science, August, 1893, Mr. W. D. Matthew puts on record the important discovery of antennæ in *Triarthrus beckii*, and gives illustrations of a number of this species showing these appendages. The specimens were collected by Mr. Valiant in the Hudson River shales near Rome, N. Y. Walcott suspected an antennal system in the Trilobites, and looked for it by means of sections, but failed to find a trace.

In discussing this valuable addition to biological knowledge, Mr. H. M. Bernard (Nature, Oct. 12, 1893) refers to the appearance and position of the antennæ as described by Mr. Matthew and draws the following conclusions:

"(1) All trilobites had antennæ, which except, as far as we know, in the case of *Triarthrus beckii* alone, remained shut in under the head shield.

"(2) These ventrally placed antennæ were inserted, approximately, one on each side of the labrum.

"It seems to me that these natural conclusions from the facts go far to establish the relationship originally maintained by Burmeister, and recently elaborated by the present writer (The Apodidæ, Nature Series, 1892). But however weighty the arguments (amounting, it seemed to me, to a proof) in favor of this relationship, the inability actually to

demonstrate the existence of the antennæ was a felt weakness. That weakness has now been finally removed, and my arguments have been fully confirmed by the finding that the Trilobites had antennæ in practically the same position as the anterior pair in the Apodidæ.

"The Trilobites may, therefore, take a firm place at the root of the Crustacean system, with the existing Apus as their nearest ally."

Development of the Brachial Supports in Dielasma and Zygospira.—Some interesting results have been obtained by Messrs. Beecher and Schuchert in studying the development of the brachial supports of the Terebratellidæ. Some of the latest are embodied in a paper published in the Proceeds. Biol. Soc. Washington, 1893, in which the authors show that the most primitive form of the loop in the Ancylobrachia is centronelloid and that therefore Centronella represents a larval or immature condition of the higher genera. For demonstration the authors use the paleozoic species, *Dielasma turgida* and give drawings of six sections to show the development of the loop.

It is also shown that in *Zygospira recurvirostra* the primitive arm support is a terebratuloid loop having a Centronella form, which undergoes several modifications before the growth of the spiral lamellæ, in so far resembling the development of Dielasma. The spirals then develop as two slender converging lamellæ, curving toward the ventral valve, originating from the outer pointed ends of the loop. When maturity is attained there are about three volutions in each spiral cone. Sectional drawings illustrate this series of changes.

Zygospira is the earliest spire-bearing genus known, and from the study of the ontogeny and phylogeny of its species the authors conclude that the Ancylobrachia are older and more primitive than the Helicopegmata.

According to the authors these results throw doubt on a number of Lower and Upper Silurian species described as having recurved loops and previously referred to Macandrevia or Waldheimia. The facts indicate that *Waldheimia mawii*, described by Davidson, is the young of *Davia navicula* Sowerby.

Geological News.—Mesozoic.—In a recent journey across the plateau of Shan-si, China, Mr. Obrucheff discovered some fossil plants in the middle parts of the series of deposits which cover in China, the carboniferous formation, and which Richthofen had described under the names of *Meberkohlen-sandsteine* or *Plateau-sandsteine*. These plants indicate that the middle portions of this formation belong to the Mesozoic age, and are Triassic or Liassic. (Nature, Jan., 1894.)

In a report on the Cretaceous area north of the Colorado Mr. J. A. Taff shows the detail of stratigraphy in four sectional views which give a concise view of the variations in thickness and structure and the relations of each division and formation to its associate divisions or formations, from the Brazos river on the south to the Red river valley on the north. Some attention is given to the soils of this region, and considerable definite information concerning the artesian water supply. The stratigraphic work is largely based on the paleontological determinations of Prof. F. W. Cragin.

Prof. Cope recently described two new species of Plesiosauroids from the Pierre formation of the Upper Cretaceous of South Dakota, under the names *Embaphias circulosus* and *Elasmosaurus intermedius*. The first named represents a new genus allied to Pliosaurus, having a short neck and strongly biconcave vertebræ. He also described the construction of the posterior part of the skull in another Plesiosauroid, the *Cimoliasaurus snovii* of Williston, showing that the supratemporal and supramastoid bones are both present and distinct. (Proceeds Amer. Philosoph. Soc.).

Cenozoic.—As to the origin of certain hydrocarbons of Utah, Mr. M. E. Jones considers the theory of an animal origin advocated by Newberry to be the only tenable one. The deposits with one possible exception, are all either Eocene or Miocene, and their source, according to the author, being the overlying or adjacent bituminous beds. These remarks apply only to the deposits situated near the coal beds of Utah in the neighberhood of Pleasant Valley Junction. (Science Dec. 1893.)

ZOOLOGY.

The Irritability of Noctiluca.—M. Jean Massart has been conducting a series of experiments to ascertain to what stimulants the Noctilucæ respond, as shown by their phosphorescence, and to what extent the phosphorescence is modified by exterior agencies. The author finds that these organisms are sensitive (1) to a slight agitation of the water, (2) to sudden variations in the temperature and density of the water, and (3) to a great number of chemical substances. As to the first stimulant mentioned, the author discovered, by an ingenious experiment, that the agitation of the water produces a deformation of the body of the Noctiluca, and it is this deformation which causes the phosphorescence, and not a vibration transferred to the animal from the water in motion. The experiments testing the effect of certain volatile substances upon the organisms are exceedingly interesting. Amyline produces hyperesthesia, the light is more intense than in normal individuals. This condition lasts for five minutes, then all is dark. At a slight blow on the vessel the phosphorescence reappears, showing that sensibility has not been lost. Bromoform acts as an anesthetic. For about five minutes the Noctiluca subjected to its influence emit a feeble light which slowly fades out. At the end of twenty-five minutes the light is almost imperceptible; anesthesia persists. After twenty hours the normal state is recovered. The effect of acetone is similar, but more rapid in action. At the end of five minutes the phosphorescence disappears entirely, and at the end of twenty-eight minutes a slight tap on the vessel causes a diffused light, which persists for some seconds showing a return to the normal state.

Some substances produce anesthesia immediately, without any display of irritability (alcohol, methyl and paraldehyde); others result in the death of the organism without any luminous reaction (piperidine). Chlorhydrate of morphine and metaphosphate of sodium appear to have no effect upon the Noctiluca, which is astonishing since the latter substance is considered an energetic coagulant of the albuminoids.

While a slight agitation of the water containing Noctiluca increases the phosphorescent light, a violent shaking destroys it. This the author believes, is due to a blunting of the sensibility of the organism to the shock. A few minutes in quiet and darkness restores the animal to its normal irritability.

In general, the Noctiluca responds more readily to stimuli at night than in the day-time, and this is true even under artificial conditions. For instance, the record of one set of animals kept in the light from the beginning to the end of the experiment, and that of another kept in the dark is almost identical. M. Massart is inclined to attribute this regular variation of sensitiveness to memory on the part of the animal rather than to the influence of light, and his experiments would appear to prove his theory.

That the irritability of the Noctiluca varies with the temperature and density of the water is demonstrated in a few carefully conducted experiments, the results of which are given in tabulated form. Incidentally, M. Massart observed that the normal specific gravity of the the Noctiluca is 1.014, but that this is increased or lessened with the varying density of the water.

In conclusion, the author calls attention to the analogy between the irritability of the *Mimosa pudica* and that of the Noctiluca, the one manifesting itself in movement, the other by the emission of light. (Bull. Sci. de la France et de la Belgique, T. XXV, 1er Partie, 1893.)

The Production of Sound Among the Ants.—That ants have some means of communicating with each other is well-established. The experiments of Landois and those of Lubbock suggest that this communication is carried on by means of sounds produced and heard by these small creatures, but which the human ear is incapable of appreciating. The observations of M. C. Janet, published in *Ann. Entomol. de France* (Vol. LXII, p. 159) show that certain species of the Formicidae, notably *Myrmica rubra* L. and *Tetramorium cæspitum* L., are in the habit of making a stridulating noise, probably by reciprocally rubbing superficial parts of the body. A demonstration of this fact is very simple. On a small pane of glass put a ring of soft putty, and after carefully dropping in the middle of the ring, by means of a funnel, a mass of ants freed from bits of earth or vegetable matter, quickly cover them with a second pane of glass and press it down until there is just barely room between the two pieces of glass for the ants to move. If provision has been made for renewal of air the imprisoned ants will live for several days. On holding this little box of ants to the ear and listening attentively, a murmur is heard very similar to that made by a liquid boiling gently in a closed vessel, and before long distinct stridulations can be heard in the midst of the murmuring. These sounds are heard only when the ants are disturbed.

M. Janet concludes that the numerous rugose surfaces which are found on the body of ants in such places that two of them can be rubbed together, are probably the organs which produce the stridulating sounds of the Formicidae. These rugosities have other uses. For instance, those about the articulations serve to hold the body stiff at will at that particular point, an advantage to the animal in pushing or carrying heavy weights up steep slopes. (Revue Scientifique, January, 1894.)

Zoological News—MOLLUSCA.—Mr. J. I. Peck's report on the Pteropods and Heteropods collected by the U. S. Fish Commission steamer Albatross, during the voyage from Norfolk Va., to San Francisco, Cal., 1887–88, is published in the Proceeds. U. S. Natl. Mus., Vol. XVI. The material is the result of both dredging and surface collection. The Pteropods belong almost exclusively to the family Cavoliniidae, representing all the species except one of the genus Cavolinia, the species of Cuvierina, as also six of Clio. The Heteropods are included in the three genera Atlanta, Carinaria and Ianthina. According to the author, results show that there are no marked distinctions between the kinds and distribution in the Atlantic and Pacific waters of northern South America.

UROCHORDA—A new Tunicate from the Pacific Coast is described by Mr. W. E. Ritter, who assigns it to the genus Perophora. The new species presents an interesting character. In very many, though not all of the colonies, the ascidiozooids are as completely imbedded in a common test as they are in Botryllus or Goodsiria. In recognition of this transitional character the author proposes for it *annectens* as a specific name. (Cal. Acad. Sci., Vol. IV, 1893.)

MAMMALIA—Two new Neotomæ from the Plateau region of Arizona are described by C. Hart Merriam. One of the new species, *N. arizonæ*, presents a remarkable combination of the external characters of the bushy-tailed wood rats with the cranial characters of the round-tailed species. The other, *N. pinetorum*, is a round-tailed species allied to the *N. fuscipes* group of California. In this connection Mr. Merriam calls attention to an important cranial character, heretofore overlooked, which serves to distinguish *Teonoma* from *Neotoma*. In the skulls of the round-tailed wood rats there is a long open slit on each side of the presphenoid and anterior third of the basisphenoid. These openings the author designates the *spheno-palatine vacuities*. (Proceeds. Biol. Soc. Wash., 1893.)

EMBRYOLOGY.[1]

Cleavage and the Formation of Organs.—An important addition to the accumulations of experimental embryology has been recently made by Oscar Hertwig[2] in the hope of clearing up the fogs that envelop the important subject of the relations of the cells of a cleaving ovum to the subsequently formed organs of the adult.

While His, Roux and Weismann have seen in the ovum or germ a preformation of parts or organs and looked upon the cleavage cells as different in quality from the first, regarding the process of embryo formation as an evolution (in the old sense), Driesch and Hertwig, from experimental studies, now regard the ovum as *isotropic*, its first cells are qualitively alike, the embryology is an epiginetic formation of organs. The process is one of inter-relation of the cleavage cells.

In the present paper the author describes a long series of experiments made upon frogs' eggs and applies them to the overthrow of Roux's main position, meeting that investigator upon his own grounds.

The methods used are: the compressing of the eggs between glass slides placed horizontally, vertically or inclined; the compressing of the eggs by drawing them into narrow glass tubes placed horizontally or vertically; the partial separation of the first two cleavage cells (in the Triton) by means of a loop of fibre from a cocoon tied about the the egg; the injury of one of the first two cells by the insertion of a needle; and the same result by the use of an electric current, continuous or interrupted.

We will first give some of the chief facts obtained by each method and then the author's conclusions.

When the eggs lie in the normal position upon a glass slide but are compressed by the slide that rests upon them so as to be no longer spherical but considerably flattened, the main axis from the black to the light pole being thus made the shorter, by a third or a fourth, the eggs cleave in an abnormal manner. The third plane is not horizontal but more nearly vertical so that the first eight cells form a bilaterally symmetrical set of four on each side the second cleavage plane. Again, if the pressure is exerted upon the sides of the egg, which is done by plac-

[1]Edited by E. A. Andrews, Baltimore, Md., to whom communications may be sent.

[2]Archiv fr Mik. Anatomie. 42. 22 Dezember, 1893, pps. 662–794, Pls. 39–44.

ing the slide vertical and allowing the eggs to take up their normal position before the second slide is pressed upon them, the cleavage is abnormal. The second plane is not a vertical one but is horizontal so that two black-pole cells and two light-pole cells are formed. The two former cells are very small and divide up by somewhat vertical planes parallel to the first. Thus the second, normal, plane remains long absent. When the plates are inclined to 45° a still different modification of cleavage results.

The eggs that are drawn into narrow tubes are distorted into cylindrical or barrel-shaped masses that cleave abnormally. When the tube rests horizontally the first plane is vertical or normal but always at right angles to the axis of the tube, the second is normal, that is, at right angles to the first, but the third is also vertical and not horizontal: the fourth is horizontal.

When the tube is placed vertically the black part of the egg is uppermost and the cleavage is again altered by the pressure of the tube. The first plane is oblique and variable, but divides off a smaller upper cell from a larger lower cell.

All these abnormal modes of cleavage may, the author maintains, be explained upon his principle that the cleavage plane is at right angles to the axis of the nuclear spindle and that the position of the spindle-axis is dependant upon the shape and character of the protoplasm about it; the poles of the spindle lie in the directions of the greatest masses of protoplasm. Pressure acts by changing the shape of the protoplasmic mass and thus inducing a new direction for the nuclear spindles. That in the frog different forms of cleavage result when the egg is pressed from the side or from above downward is to be explained by the quality of the protoplasmic masses, the nature of the protoplasm, admixture of yolk, etc. being a factor as well as its mass in regulating the direction of the nuclear spindle. This explanation is thus more fundamental than the principles of surface tension and rectangular intersections of cleavage planes, which follow in part from this action of mass upon nuclear arrangement.

If the eggs remain under pressure between the plates or in the tubes they continue to develop, form gastrulas and, in some cases, larvæ. This furnishes a good means of confirming the contention of Pfluger and of Roux that the medullary folds really are formed upon that side of the egg which is at first the light colored lower side though they normally appear upon the upper side and would hence be naturally regarded as formed from the black or animal-pole side.

Between horizontal glass plates the gastrulation takes place so that the crescentic blastopore lip appears upon the edge of the lower side of the disk-shaped egg, at any point of this periphery. It then travels, in some way not observed, across the lower, flat surface, and closes at a point of the periphery diametrically opposite to that whence it started. Now in sections it is found that the yolk mass is at first at the end near the first position of the blastopore, then shifting, lies at the other end.

If the egg were free and not held fast by the pressing plates this shifting of the center of gravity would tend to revolve the egg so that its lighter colored part would become uppermost. Meanwhile the head fold and medullary folds come in near and along the region traversed by the blastopore (they are found upon the flat *under* side of the compressed egg) and hence would normally appear upon the upper side if this rolling of the egg took place.

Passing over some other interesting observations we may mention those made upon eggs that were forced to develop up-side-down. This was done by turning them over, under pressure, after the first or second cleavages. The light colored part of the egg thus remains uppermost The eggs develop normally at first but finally when gastrulation begins the blastopore is irregular in shape and the yolk is asymetrically distributed so that very imperfect and monstrous gastrulas result.

An attempt to separate the first two cells of tritons by drawing a loop of fine silk about the constriction between them did not succeed, since the two cells remained connected by an isthmus. Yet as they were held partly apart some curious modifications in the development resulted. The results are, however, very diverse. Each cell may cleave and a dumbell-shaped blastula result and eventually a monstrous embryo formed half upon one side of the thread, half upon the other or chiefly upon one side and partly upon the other. The nervous system may be outlined altogether upon one of the parts kept apart by the thread.

What may be considered the most important part of the paper is that treating of Hertwig's repetition of Roux's experiments upon the development of frogs eggs in which one of the first two cells is destroyed or injured by needle thrusts.

Such eggs continue to develop, but produce abnormal embryos. Roux maintained that the uninjured half of the egg formed a half blastula, half-gastrula, etc. Hertwig claims that this is not the case and figures many sections that support his claim very convincingly.

The development of the uninjured half of the egg is not as it would be in an entire egg but is so modified by the presence of a partly dead mass adjacent to it that it produces what may be called rather an abnormal blastula with an inclusion of inactive or dead yolk than in any sense a half-blastula.

Later, abnormal gastrulas are formed. These, however, are not *Semigastrulæ laterales*, *anteriores* or *posteriores* as Roux describes, but gastrulæ checked and distorted in their formation.

It seems, moreover, that only the presence of the inactive or dead yolk of the injured cell prevents the living cell from developing into a complete small gastrula as in the echinoderm experiments of Driesch. This dead or injured mass remains intimately attached to the live cell and hence is incorporated as a part of the embryo which it modifies somewhat as the yolk of a meroblastic egg modifies the part that forms the embryo.

Some eggs develop even the medullary folds and the notochord and form parts of larvæ. These are, however, very incomplete and also much varied in character; since, apparently, the injured cell is killed, coagulated, only in the part near the needle hole and may become, elsewhere, utilized as part of the embryo, this embryo will be more or less perfect according as the needle thrust has destroyed more or less and even according as it has destroyed one part or another of the cell, for thus the dead part will come to occupy a ventral or a dorsal position, etc., in the embryo.

This description of the formation of embryos that are more or less complete, according as the mass of inert substance is less or greater, is strongly opposed to the conception of Roux that, namely, the half egg first formed a half embryo. Yet Roux allowed that a more complete embryo was *subsequently* formed from the half by a process of revivification of the inert half, by what he called postgeneration. The ultimate result is thus the same according to either investigator.

Moreover Hertwig concedes that some process of "postgeneration" takes place to convert part of the inert mass into active cells; the injury to the cell having been in part but temporary so that it may later take part in forming the embryo.

While Roux insists upon the power of one cell to develop by itself as a half embryo and then to coerce the inactive half into the subsequent formation of the complete embryo, Hertwig lays stress upon the continuity and uniformity of a process that is from the first a formation of a whole embryo by the half-egg, subsequently, in part, assisted by the slow acting injured half.

With an omission of a critique upon Roux's conceptions of developmental processes we pass to the general conclusions that end the paper

Pressure that changes the shape of the amphibian egg induces great changes in the directions and sequence of the cleavage planes and in the size of the cells.

The direction of the planes results from the form of the cell and the distribution of its protoplasm.

There is no causal connection between the first planes and the axes of the body; the main axis of the body is not determined by the position of the first or second cleavage planes.

In the various induced forms of cleavage the nuclei that are formed become, in the different cases, distributed to very various parts of the yolk; they may be vicariously distributed to all parts of the yolk.

As the cleavage does not separate parts of the yolk predestined to form definite parts of the animal, so also the nuclei are not qualitatively divided into different kinds of nuclear material for the various cells. Yet normal embryos with normally placed organs arise from such mixed up or unnaturally distributed nuclei.

The egg contains no definite substance set apart to form special organs (liver-, skin-, retina-forming material) but it is isotropic. The contents of the egg ceases to be isotropic and becomes more and more specialized and organized in the process of cell multiplication with its important chemico-physical transformations (such as increase in the nuclear material).

In spite of this isotropy the egg is a definitely organized cell with yolk, protoplasm, etc., of different specific gravity.

This specific nature of the egg contents and also the shape of the egg exercises a directive influence over the process of development; the embryo at first must be adapted to the form of the egg.

The shape and position of the egg determine the position of the first cleavage planes.

As no rearrangement of heavy and light portions takes place in cleavage the distribution of mass in the egg corresponds to that in the blastula.

When the walls of the blastula are not uniform the gastrulation can take place only in a special zone which is below the equator when there is less yolk, as in the amphibian egg, and above when there is very much yolk, as in meroblastic eggs.

From an oval or elongated egg there is formed an elongated blastula, gastrula, etc. (in triton and insects, etc.).

As many eggs have also a bilateral arrangement of their component substances there must follow a bilateral blastula in which the place for formation of the blastopore will be more sharply defined.

The chief axes of the embryo may correspond approximately to the first cleavage planes in eggs that are bilaterally symmetrical or that have one long diameter, since the character of the egg determines both.

In the gastrulation of the amphibian egg there is a revolution about an axis cutting the plane of symmetry and the plane of equilibrium.

Eggs of complex consistency are acted upon by gravitation so that they are oriented and if bilaterally symmetrical stand with the plane of symmetry vertical since this is also the plane of equilibrium.

If such eggs are forced to develop in a constrained position they form asymmetrical embryos so that gravitation is, in a sense, one of the influences determining structure.

If one of the first two cells of the egg is destroyed the other develops into a tolerably normal embryo having, however, some of its less important regions defective.

When one cell is but partly destroyed it may later form cells that are added to the uninjured half to help form the embryo. This secondary formation of cells in the injured half may be from the uninjured nucleus of that cell, or sometimes, by the migration of nuclei from the uninjured egg-half into the injured egg-half.

The development of the uninjured half, by itself or with the aid of part of the injured half, follows the same laws as the natural ontogeny of the species.

The injured yolk acts in the development of this half of the egg as the nutrient material does toward the formaitive in a meroblastic egg.

The process of postgeneration described by Roux does not take place nor is there a revivification of the destroyed egg-half.

Embryos with cleft blastopore cannot form double monsters by the process of postgeneration that Roux brought in to explain such a formation.

We cannot form at will half-anterior, -posterior or -lateral blastulas or embryos by destroying one of the first two cleavages cells.

In these cases of injury complex processes of adjustment may result in the formation of a normal embryo under changed circumstances.

The results obtained by these pressure experiments as well as the injury to one of the cleavage cells demonstrate the untenability of the mosaic theory, the theory of specialized germ areas and Weismann's theory of germ plasm.

The egg is a specifically organized one-celled organism that develops epigenetically by process of multiplication of cells with subsequent differentiation.

Since each cell comes from the first (the egg) by division it likewise contains the beginnings of the whole and becomes differentiated and specific during process of development according to the position it occupies in the whole at any period (gastrula, etc.). The reasons leading up to this position may be put under the following seven heads: 1. A complete organism may be formed from one of the first two or four cells; accordingly in different cases cells of like origin must be put to forming different organs. 2. As the gastrula mouth may appear at various parts of the periphery the cells concerned must have different ates in different cases. 3. The same is true in the abnormal cases of formation of multiple gastrula mouths; then there may be formed four instead of two eyes, ears, etc. 4. Frog's eggs that develop when held up-side-down must have the material utilized in a different way from the normal. 5. Thus also the triton larvæ show various ways of using the similar cells when the first two are partly separated by a thread. 6. When the frog develops up-side-down cases occur in which the lip of the blastopore is rolled outward and unites with the other lip so that the line of union is not between the edges of the lips but between the edge of one and the turning out surface of the other. Then the notochord and the medullary plate would be formed from cells quite other than those normally acting. 7. Changes in the cleavage process that so mix up the nuclear substance that it is assigned to different parts of the yolk in different eggs have no influence upon the normal result of development.

Thus in place of the mosaic theory of Roux and the germ-plasm theory of Weismann we may substitute the theory of the controlling inter-adjustments of the embryonic cells and later of the tissues and organs.

ENTOMOLOGY.[1]

The Four-lined Leaf-bug.—Another satisfactory monograph of a hitherto little-known injurious insect comes from the Cornell University Agricultural Experiment Station.[2] Mr. Slingerland reports that *Pœcilocapsus lineatus* has been destructive to currant foliage in New York for several years, sometimes rivalling, in damage done, the common currant-worm. Bushes on the university grounds "looked as though a fire had swept over them, leaving the prominent topmost leaves brown and dead." Such injury checks the growth of the bushes and materially lessens their productive capacity the following season. The past history of the insect is reviewed at some length, the discussion showing that it has been recognized as a destructive species for many years.

The four-lined leaf-bug shows an extraordinary range of food-plants, 54 species being listed as attacked by it. "Botanically considered, these lists are of interest, as they show an exceedingly wide range of food-plants for a single species of insect. Rarely do we find an insect attacking indiscriminately so many different plants with such widely different characteristics. The fifty-four species of plants represent forty-nine genera in thirty-one different families of the Flowering Plants. The Gymnosperms, like the pine, etc., are not represented, and but one genus (*Hemerocallis*) of the Monocotyledons. Fourteen of the plants are useful for food or medicine; twenty-nine are ornamental; while but eleven are wild species. Thus the beneficial results from the attack, rarely severe, of the insect upon the weeds, so termed, is slight compared with its frequently very injurious attacks upon the cultivated plants."

"The insect usually makes its first appearance in New York about the middle of May on the newest, tenderest terminal leaves. The insects are then so small and active in hiding themselves that they are not apt to attract attention. Their work, however, soon becomes apparent. Minute semi-transparent darkish spots appear on the terminal leaves. These spots are scarcely larger than a commonpin's head, and are round or slightly angular in shape, depending upon the direction of the minute veinlets of the leaf which bound them. The insect has inserted its beak into the leaf and sucked out nearly all of the opaque green pulp or parenchyma of the interior within a small area bounded by the little veinlets." These spots later turn brown

[1] Edited by Clarence M. Weed, New Hampshire College, Durham, N. H.

[2] Bull. 58. The Four-lined Leaf-bug. By Mark Vernon Slingerland. October, 1893.

and die; and, eventually, as the insects increase in size and destructive power, the leaves become withered and dead, as represented in Fig. 2 of the accompanying plate. "When all the tenderest leaves have succumbed, the insect continues its attack on the older leaves lower down. During its lifetime a single insect will destroy at least two or three currant or gooseberry leaves. This accounts for the fact that the injury wrought often seems much out of proportion to the number of insects at work.

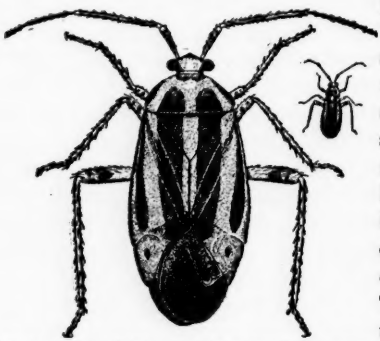

FIG. 1.—The adult insect; its natural size represented in small figure at the right.

"When the insects are very numerous, the growth of the shoots is often checked, they droop, wither, and die. Some have thought that this blasting of the growth was caused by a poisonous saliva which the insect injected into the wound made by its beak. However, it is more probable that the shoot dies or its growth is checked on account of the death of its breathing organs—the leaves. On the currant, gooseberry, and many other plants the insect confines its attacks to the leaves, but on some ornamental plants, as the dahlia and rose, the most frequent point of attack seems to be the buds."

Mr. Slingerland has, for the first time, traced the annual cycle of this pest. He finds that "the nymphs appear in the latter part of May upon shrubby plants where they continue to feed upon the tender leaves for two or three weeks, undergoing five moults. The adults appear early in June and often spread to different surrounding succulent plants. Egg-laying begins in the latter part of June; the eggs being laid in slits cut in the stems of shrubs near the tips of the new growth. The adults disappear in July and the insect hibernates in the egg. Only one brood occurs each year in our State."

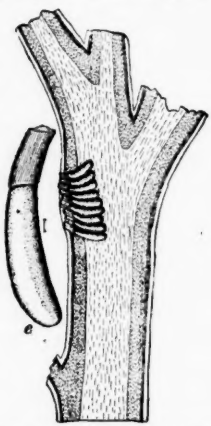

FIG. 2.—Section of currant stem showing eggs in position; *e*, egg, greatly enlarged.

The eggs are deposited in the stems, several being placed side by side in a longitudinal row (Fig. 2). The egg clusters as they appear on the surface of the young shoots are represen-

ted in the upper figure of the accompanying plate. After much experimenting, Mr. Slingerland finds that "there are three practicable methods by which this pest can be controlled: kerosene emulsion for the nymphs; destruction of the eggs by pruning; and the capture of the nymphs and adults by jarring into receptacles where they are destroyed. Circumstances will largely determine which method will prove the most practicable in specific cases."

The bulletin concludes with an extended bibliography and synonymy, and is represented by 13 figures, four of which are reproduced herewith.

Indiana Orthoptera.—Two important papers, by Mr. W. S. Blatchley of the Terre Haute High School, have recently appeared.[3] The first is entitled the Locustidæ of Indiana, thirty-nine species being catalogued, while a list of twelve others that are likely to be found in the State is given.

Concerning the musical powers and general habits of these katydids and their allies, Mr. Blatchley writes: "The stridulating or musical organ of the males is quite similar to that of the male cricket, being found at the base of the overlapping dorsal surface of the tegmina, and usually consisting of a transparent membrane of a more or less rounded form, which is crossed by a prominent curved vein, which, on the under side, bears a single row of minute file-like teeth. In stridulating the wing covers are moved apart and then shuffled together again when these teeth are rubbed over a vein on the upper surface of the other wing cover, producing the familiar so-called 'katydid' sound. Each of the different species makes a distinct call or note of its own, and many of them have two calls, one of which they use by night and the other by day. Anyone who will pay close attention to these differ-

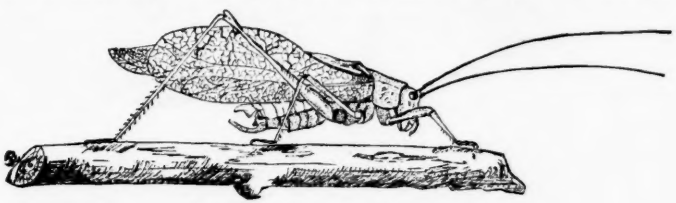

Fig. 3. A Locustid. [after Bruner].

ent calls, can soon learn to distinguish each species by its note as readily as the ornithologist can recognize different species of birds in the same

[3] Proceedings Indiana Acad. Science, 1892, pp. 92–165.

manner. The ear of these insects, when present, is also similar in structure and position to that of the crickets, being an oblong or oval cavity covered with a transparent or whitish membrane, and situated near the basal end of the front tibiæ.

"The young of the Locustidæ, like those of the other families of the order, when hatched from the egg, resemble the adult in form, but are wholly wingless. As they increase in size they molt or shed their skin five times, the wings each time becoming more apparent, until after the fifth molt when they appear fully developed, and the insect is mature or full-grown, never increasing in size thereafter. Throughout their entire lives they are active, greedy feeders, mostly herbivorous in habit; and where present in numbers, necessarily do much damage to vegetation."

Mr. Blatchley's other paper is entitled "The Blattidæ of Indiana." Seven species belonging to five genera of cockroaches are catalogued.

"From the other Orthoptera the Blattidæ differ widely in the manner of oviposition, as the eggs are not laid one at a time, but all at once in a peculiar capsule or egg case called an oötheca. These capsules vary in the different species as regards the size, shape and the number of eggs they contain, but they are all similar in structure. Each one is divided lengthwise by a membranous partition into two cells. Within each of these cells is a single row of cylindrical pouches, somewhat similar in appearance to those of a cartridge belt, and within each

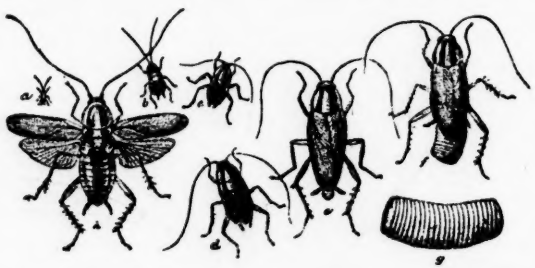

FIG. 4.—Croton Bug: *a*, first stage; *b*, second stage; *c*, third stage; *d*, fourth stage; *e*, adult; *f*, adult female with egg-case; *g*, egg-case —enlarged; *h*, adult with wings spread—all natural size except *g*.

pouch is an egg. The female cockroach often runs about for several days with an oötheca protruding from the abdomen, but finally drops it in a suitable place, and from it the young in time emerge." An introduced tropical species, *Panchlora viridis*, is viviparous.

"All young cockroaches resemble the parents in form, but are wholly wingless, the wings not appearing until after the fifth or last molt. The young are often mistaken for mature individuals." The stages of the common "Croton Bug," as represented by Dr. Riley, are shown in Fig. 4.

A Curious Hemipteron.—About the middle of January I received a curious looking specimen of Hemiptera which was taken in an agricultural implement warehouse. Owing to the extremely warm weather, the creature was quite active, and at first glance resembled an animated bit of rusty metal upon legs.

It proved to be of the family Reduviidae, recognized according to Latrielle by the elongated head which is free from the thorax, prominent eyes and two ocelli, antennæ of moderate length, filiform toward the ends and stout incurved beak. The tarsi are three-jointed, and the legs long and fitted for running.

This insect could probably be classified with *Reduvius personatus*, although of a reddish-brown rather than black, as members of this genus are said to have a habit of enveloping themselves in a thick coating of dust. This particular specimen was entirely covered with iron-dust and rust, possibly the only material at hand, and even the first joints of the antennæ and the densly hirsute limbs were thickly encased. The fourth hair-like antennal joints and the tarsi were clear of dust. Under the microscope numerous sharp, shining particles of steel and iron filings were to be seen, and the back, wingless and very concave, was heavily weighted. The insect moved rapidly, but with a peculiar creeping and halting gait, and proved to be very hard to kill. I first experimented with sulphur smoke, which had no perceptible effect. Then I placed the specimen in a prepared insect bottle, containing cyanide of potassium so strong that almost any soft bodied insect would become motionless instantly, and in this Reduvius lived several hours. Whether this was owing to the season of the year or to its unique coat of mail, I am unprepared to say.—Laurene Highfield, *Quincy, Illinois.*

North American Membracidæ.—Dr. F. W. Goding has prepared a very useful catalogue of North American tree-hoppers.[4] Nearly three hundred species are included in the list, a considerable number of them being here described for the first time. Dr. Goding

[4] Bibliographical and Synonymical Catalogue of the Described Membracidæ of North America. By F. W. Goding, M. D., Ph.D. Bull. Ill. St. Lab. Nat. Hist., V. III, Art. XIV. Champaign, Ill., 1894.

has had access to ample collections and literature, and has filled nearly one hundred pages with the bibliography of this comparatively small family.

Colors of Lepidopterous Larvæ.—Prof. E. B. Poulton has an abstract of a memoir[5] entitled "The experimental proof that the colors of certain Lepidopterous Larvæ are largely due to the modified plant pigments derived from food." He divided into three lots one batch of eggs laid by *Tryphæna pronuba*, and fed them in darkness on green leaves, on yellow etiolated leaves and white midribs of cabbage. The last, whose food contained neither chlorophyll nor etiolin, were entirely unable to form the green or brown ground color.—*Journal Royal Microscopical Society.*

Effect of Arsenites on Caterpillars.—Professor C. H. Fernald reports[6] that in a series of experiments with various insecticides it was found that "gypsy caterpillars, when half-grown or larger, are not destroyed by any proportion of Paris green in water that can be used on fruit trees without injury to the foliage." A new insecticide—arsenate of lead—was tried with satisfactory results. "It did not injure even the most delicate foliage, however large a proportion was used. In one case, 24 pounds to 150 gallons of water were used without injury to the leaves."

Life-history of the Mole Cricket.—Some interesting details of the life-history of the European mole cricket (*Gryllotalpa vulgaris*) were recently communicated by M. F. Decaux to the *Societé Entomologique de France.*[7]

In some specimens under observation copulation took place April 15; the eggs were deposited by the end of April, and hatched May 15. At first the young are gregarious. All the young of a given brood do not mature at the same time; those maturing earliest reproduce 25 months after hatching, others 28 months, and a few even 35 months. These insects, M. Decaux says, are essentially carnivorous—feeding on insects, worms and slugs—but they accommodate themselves very well to a vegetable diet. He believes that the galleries are made not to pursue insects, but as places of defense and concealment.

News.—Prof. Charles Robertson has issued another instalment of his valuable papers on Flowers and Insects.

[5] Trans. Ent. Soc. London, 1893, pp. 255–265.
[6] Thirty-first Rep. Mass. Agr. College, p. 23.
[7] Bull. des Seances, No. 20, p. CCCXLI.

PLATE III.

FIG. 1.

FIG. 2.

Injuries of Four-lined Leaf-bug.

In his address as retiring president of the Cambridge Entomological Club, Mr. Wm. H. Ashmead discussed "The Habits of the Aculeate Hymenoptera." The address is being printed in *Psyche*, and is a paper of unusual biological interest.

Mr. F. J. Buckell discusses, at some length,[8] the proper name for the butterfly, variously known as *Danais archippus* or *Anosia plexippus*, and concludes that the insect should be called *Anosia archippus*.

Mrs. A. T. Slosson publishes[9] an interesting list of insects taken in the alpine region of Mt. Washington.

Mr. Howard Evarts Weed issues, as Bulletin 27 of the Mississippi Experiment Station a valuable discussion of insecticides, and their application.

In Bulletin No. 23 of the Maryland Experiment Station, Dr. C. V. Riley treats of some Injurious Insects of Maryland.

Mr. H. F. Wickham records[10] some interesting observations on the habits of oceanic Hemiptera. His observations indicate that Halobates may be drowned by submergence; and open up again the question as where these insects remain during stormy weather.

In his annual report on the gypsy moth, Prof. C. H. Fernald says: "In 1891, some experiments were made to determine what could be done toward entrapping the male moths by exposing females. In the spring of 1893, Prof. Shaler recommended that the monitor trap be tried on a large scale. This was done by enclosing the females in boxes covered on two sides by fine wire netting, and attaching to such boxes two sheets of paper covered with a resinous coating to which the male moths adhered. Fifteen traps were exposed in Malden, and 1,771 male moths were caught. The fact that so many moths were destroyed at a small expense, seems proof that trapping will prove an effectual and inexpensive method of preventing the increase in the numbers of the moth, especially as the males now seem to be comparatively scarce."

[8] Ent. Record, V. 1.
[9] Ent. News, V. 1.
[10] Ent. News. V. 33.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Indiana Academy of Sciences.—The Indiana Academy of Science held its ninth annual meeting in the rooms of the State Board of Agriculture, at the Capitol, Indianapolis, Dec. 27 and 28th, 1893, as stated in our last issue.

The following officers were elected for 1894.

President, Prof. W. A. Noyes, Rose Polytechnic Institute, Terre Haute; *Vice President*, A. W. Butler. Brookville; *Secretary*, Prof. C. A. Waldo, De Pauw University, Greencastle; *Ass't. Secretary*, Prof. W. W. Norman, De Pauw University, Greencastle; *Treasurer*, Prof. W. P. Shannon, Greensburg.

Boston Society of Natural History, January 3, 1894.—The following papers were read:—Mr. Leon S. Griswold, A brief description of the physical geography of Arkansas.

January 17.—The following papers were read: Mr. T. A. Jaggar, Experiments in the formation of ripple-marks. (Specimens were shown); Prof. N. S. Shaler, The topograpic evidence of ancient earthquakes.

SAMUEL HENSHAW, *Secretary.*

The Biological Society of Washington, January 27.—The following communications were read: Mr. J. N. Rose, A Botanical Trip to Northwestern Wyoming. Mr. B. T. Galloway, A consideration of the Anatomical and Physiological Processes involved in Leaf Fall; Dr. Theo. Gill, The Segregation of the Osteophysarial Fishes as fresh water forms; Dr. C. W. Stiles, An Interesting Cestode from India.

The Annual Address of the President of the Biological Society was delivered by Prof. C. V. Riley, in the lecture room of the Columbian University, at half past eight o'clock on Monday evening, January 29, 1894. The subject was Social Insects from the Psychological and Evolutional Points of View.

FREDERIC A. LUCAS, *Secretary.*

New York Academy of Sciences, Biological Section, January 29.—A paper was read by title, "A Case of reversed cleavage in a Sinistral Gasteropod," by Mr. H. C. Crampton, Jr.

Drawings were exhibited by Bashford Dean, showing original restorations of *Dipterus valenciennesii* S. & M., and of *Coelacanthus elegans* Newb.

Dr. J. L. Wortman exhibited an almost entire skeleton of *Patriofelis*, recently acquired by the American Museum of Natural History, and discussed its probable relationships. From structural characters of limbs he regards this creodont as nearest the ancestral form of the seals. Its spreading digits appear to have been webbed, and its coprolites show that its food material included turtles.

Dr. A. A. Julien read a paper on a newly discovered fungus from the petrified forest near Cairo, Egypt. Its genus is probably *Peronosporites*, and owing to remarkably perfect preservation its life history is to be determined.

BASHFORD DEAN, *Rec. Sec.*

SCIENTIFIC NEWS.

P. J. Van Beneden.—Professor Van Beneden, whose name is associated with the history of zoology, died recently, at the age of eighty-five years. One of his many contributions in aid of scientific work was the establishment, at his own expense, of a maritime laboratory at Ostend, which has since served as a model for others. His work extended throughout Zoology from the Protozoa to the Mammalia. At the time of his death he was one of the faculty of the University of Louvain.

Arthur Milnes Marshall, Professor of Biology in Owen's College, Manchester, England, who was as mentioned in our last issue killed recently by an accident, was both an investigator and a teacher of much ability, and was the author of many valuable biological papers, and of a text-book of Embryology. He is remembered in the United States, which he visited in 1884, for his activity of both mind and body. His loss is greatly regretted. It is proposed now to erect a suitable memorial.

Paul Henri Fischer.—The Museum of Natural History of Paris has suffered a great loss in the person of Dr. Paul Henri Fischer, the well-known zoologist and paleontologist, who died on November 29, after a long and painful illness. Born at Paris, on July 7, 1835, he received his early classical and medical education at Bordeaux. He became *Tuterne des Hopitaux de Paris*, in 1859, and obtained his degree of Doctor of Medicine in 1863. The study of medicine did not prevent him from devoting himself also to that of the natural sciences;

for in 1861, he had entered as Demonstrator in the Laboratory of Paleontology of the Museum of Paris, under the direction of M. d'Archiac. His researches concerned above all the living and fossil Mollusca. Since 1886, he directed the *Journal de Conchyliologie*, in collaboration with M. Crosse. From the position of demonstrator he rose to be *aide-naturaliste* (assistant), and studied with great success the marine animals of the coast of France, their geographical and bathymetric distribution. He indicated the depths at which a large number of Foraminifera, Cœlenterata, Echinodermata, Mollusca, Bryozoa, etc., can be collected on the coasts of the west of France. In collaboration with the Marquis de Folen, he undertook the study of the animals dredged in the extremely interesting region of the Gulf of Gascogne to which the name "*Fosse du Cap Breton*" has been given. The two savants discovered a large number of form hitherto unknown, and many which recalled species only known in the fossil condition. With M. Delesse, he made researches on the submarine sediments of the French shores. He was elected member of the *Commission of Dredging*, and took part, from 1880 to 1883, on board the "*Travailleur*" and the "*Talisman*" in the celebrated expedition directed by Professor Milne-Edwards. In the course of these expeditions, he noted the enormous extension of a cold fauna characterised by boreal and Arctic species, and reaching as far as Senegal, where it lives beneath a superficial fauna with intertropical characters.

Among the writings of Fischer, which number not less than 300 titles, including books, pamphlets and memoirs, we may cite: *Paléontologie de l' Asie Mineure* (in collaboration with M. d'Archiac and M. deVerneuil); *Mollusques du Mexique et de l' Amérique centrale* (in collaboration with M. Crosse); *Species général et inconographie des coquilles vivantes; Animaux fossies du Mont Léberon* (in collaboration with M. Albert Gaudry and M. Tournouer); *Paléontologie de l'ile de Rhodes; Cétacés du Sud-ouest de la France; Catalogue et distribution géographique des Mollusques terrestres, fluviatiles et marins d' une partie de l' Indo-Chine; Sur les caractères de la faune conchyliologique terrestre et fluviatile récemment éteinte du Sahara; Sur la faune conchyliologique de l'ile d'Hainan (Chine);* numerous memoirs on the malacological fauna of Lord Howe Island (Pacific Ocean); of Cambodia, of the Caledonian Archipelago Islands, of the Bay of Suez, etc. In collaboration with M. E. L. Bouvier, he published papers on the anatomical peculiarities of certain groups of Molluscs. Finally he wrote a remarkable treatise on Conchology, which has become classical. In this manual, the author shows that the classification of Mollusks ought to

be based not alone on the form of the shell, but primarily on anatomical characters.

Dr. Fischer was *Chevalier de la Légion d'Honneur* since 1871; *Officier de l'Instruction Publique* since 1881. He had obtained several prizes at the Académie des Sciences de Paris, and had been President of the Zoological and Geological Societies of France. He possessed deep erudition, was a charming talker, and after having treated a subject belonging to the domain of natural science or of medicine, he was far from embarrassed if he had to discuss philosophy, literature or esthetics. The death of this savant who was as affable as he was modest, has been a cause for general regret and for deep mourning among his large circle of friends.—EDMOND BORDAGE.

Dr. Samuel Lockwood, of Freehold, New Jersey, Died in January, 1894, at an advanced age. Dr. Lockwood was a frequent contributor to the scientific journals, and was well-known as an enthusiastic observer. His animal biographies will always be read with pleasure. They are scattered through various periodicals, but the NATURALIST probably published the majority. Such were the History of the Mocking-bird in New Jersey; the Singing Mouse; The Pine Snake; The Coati, etc. Dr. Lockwood was, for many years, a clergyman at Keyport, N. J., and subsequently became superintendent of the public schools of Monmouth Co., N. J. His interest in education was as great as it was in scientific research. He saved many valuable specimens for scientific study, among which was the type of *Plesiosaurus lockwoodii* of the Cretaceous beds, and the bones of the huge Dinosaur, *Ornithotarsus immanis.*

Mr. Samuel N. Rhoads, of Haddonfield, New Jersey, announces that he has discovered a perfect copy (2 vols.) of the long lost "Second American Edition" of Guthrie's Geography, published in 1815. This edition is the one which contains the part on American Zoology, by the celebrated naturalist, George Ord, where, for the first time, binomial scientific names are imposed upon several species of American Mammals and Birds. The article on Zoology is Mr. Ord's private annotated copy, and is intact within the second volume. A reprint of this copy is now being prepared for publication by Mr. Rhoads, to be ready for distribution in February. The reprint will be an exact reproduction of the original, and will include also comments on the marginal annotations, which, there is no doubt, were made by Mr. Ord himself.

Science Prizes.—At the recent annual public meeting of the Academy of Sciences, Paris, M. de Lucaze-Duthiers in the chair, after some commemorative words on the deaths of Sir Richard Owen, Kummer, and DeCandolle, foreign associates, and those of Chambrelent, Admiral Paris and Charcot, members of the Academy, by the president, M. Bertrand, one of the secretaries announced the names of those to whom prizes had been awarded. It will be seen that American scientists were not forgotten.

In *Geometry*, the Prix Francoeur was awarded to M. G. Robin for mathematical physics, and the Prix Poncelet to M. G. Koenigs, for geometrical and mechanical work.

Mechanics. The extraordinary prize of 6,000 francs offered by the Department de la Marine for contrivances increasing the efficiency of the navy, was distributed among M. Bourdelles (for lighthouse illumination), M. Lephay (compass with luminous index), and M. de Fraysseix (system of optical pointing); the Prix Montyon, of 700 francs to M. Flamant (hydraulics); the Prix Plumey, of 2,500 francs, to M. Lebasteur (steam-engine appliances); the Prix Fourneyron, of 500 francs, to M. Brousset (fly-wheels).

Astronomy.—The Prix Lalande, of 540 francs, to M. Schulhof (comets); the Prix Valz of 460 francs, to N. Berberich (minor planets); the Prix Janssen, of a gold medal, to Mr. Samuel Langley (astronomical physics).

Physics.—The Prix La Case, of 10,000 Francs, to M. E. H. Amagat (gasses and liquids).

Statistics.—The Prix Montyon, of 500 francs, to Dr. Marvand (diseases of soldiers).

Chemistry.—The Prix Jecker, of 1,000 francs, to M. D. Forcrand and M. Griner in equal parts, with a special prize to M. Gautier; the Prix La Caze, of 10,000 francs, to M. Lemoine (phosphorous compounds).

Mineralogy and Geology.—The Grand Prix to M. Marcellin Boule (the central plateau of France); the Prix Bordin, of 3,000 francs, was distributed among MM. Bourgeois, Gorgen, Michel and Duboin for their researches in mineral synthesis; the Prix Delesse, of 1,400 francs, to M. Fayol (Commentry strata); the Prix Fontannes, of 2,000 francs, to M. R. Zeiller (paleontology).

Botany.—The Prix Desmazieres, of 1,600 francs, to M. C. Sauvagean (Algae); the Prix Montague to MM. Cardot (mosses) and Gaillard (Fungi).

Agriculture.—The Prix Morogues to M. Millardet (mildew).

Anatomy and Zoology.—The Prix Thore to M. Corbiere (Muscineæ)

Medicine and Surgery.—The Prix Montyon was distributed among M. M. Huchard (heart diseases), Delorme (army surgery), and Pinard and Varnier (pathological atlas); the Prix Barbier, 500 francs each to MM. Sanson (heredity) and Dr. Mauclaire (osteoarthritis; the Prix Breant, being the interest on the sum of 100,000 francs, offered for a cure for cholera, was distributed among MM. Netter and Thoinot (French cholera, 1892), and MM. Grimbert and Burlureaux (treatment of tuberculosis by creosote injections); the Prix Godard, of 1,000 francs, to Dr. Tourneux (physiological atlas); the Prix Serres, of 7,500 francs, to M. Pizon (blastogenesis), with small portions to MM. Sabatier (spermatogenesis) and Letulle (inflammation); the Prix Bellion, of 1,400 francs, to Dr. C. Chabrie (physiology of the the kidney) and Dr. Constan (fatigue); the Prix Mege to Dr. Hergott (history of obstetrics); the Prix Lallemand, of 1,800 francs, to M. Trolard (venous system).

Physiology.—The Prix Montyon, of 750 francs, to M. Lanlanie (respiration), and MM. Abelous and Langlois (renal capsules); the Prix la Caze, of 10,000 francs to M. d'Arsonval (physiological effects of electricity); the Prix Pourat to M. E. Meyer (renal secretion; the Prix Martin-Damourette, of 1,400 francs, to Dr. Gerand (albuminuria).

General Prizes.—The Arago Medal to Mr. Asaph Hall (satellite of Mars) and Mr. E. E. Barnard (Jupiter's first satellite); the Prix Montyon, for improvements in unhealthy industries, was divided between MM. Garros (porcelain manufacture) and Coquillon (fire damp meter); the Prix Tremont, of 1,100 francs, to M. Jules Morin for his useful hydrostatic and other inventions; the Prix Gegner, of 4,000 franc, to M. Serret; the Prix Petit d'Ormoz, of 10,000 francs, to M. Stieltjes (mathematics), and another of the same amount to M. Marcel Bertrand (physics of the globe); the Prix Tchihatchef, of 10,000 francs, to M. Gregoire Groum-Grschimailo (the Pamirs); the Prix Gaston Plante, of 3,000 francs, to M. Blondlot (electric interference); Mme. De Laplace's Prize, consisting of Laplace's works, to M. Bes de Berc, of the Ecole Nationale des Mines.

The sixth annual meeting of the Association of American Anatomists will take place Tuesday to Friday, May 29, to June 1, 1894, at Washington, D. C., the time and place of meeting of the Third Congress of American Physicians and Surgeons, of which this Association is a constituent part.

The Botanical Club of the American Association for the Advancement of Science at a meeting held Aug. 19, 1892, adopted these principles of Nomenclature: *Resolved:* That the Paris code of 1867 be adopted except where it conflicts with the following: I. The Law of Priority. Priority of publication is to be regarded as the fundamental principle of botanical nomenclature. II. Beginning of Botanical Nomenclature. The botanical Nomenclature of both genera and species is to begin with the publication of the first edition of Linnæus "Species Plantarum," in 1753. III. Stability of Specific Names. In the transfer of a species to a genus other than the one under which it was first published the original specific name is to be retained, unless it is identical with the generic name or with a specific name previously used in that genus. IV. Homonyms. The publication of a generic name or a binominal invalidates the use of the same name for any subquently published genus or species respectively. V. Publication of Genera. Publication of a genus consists only (1) in the distribution of a printed description of the genus named. (2) in the publication of the name of the genus and the citation of one or more previously published species as examples or types of the genus, with or without a diagnosis. VI. Publication of Species. Publication of a species consists only (1) in the distribution of a printed description of the species named, (2) in the publishing of a binominal, with reference to a previously published species as a type. VII. Similar Generic Names. Similar generic names are not to be rejected on account of slight differences, except in the spelling of the same word; for example *Apios* and *Apium* are to be retained, but of *Epidendrum* and *Epidendron*, *Asetrocarpus* and *Astrocarpus*, the later is to be rejected VIII. Citation of Authorities. In the case of a species which has been transferred from one genus to another the original author must always be cited in parenthesis, followed by the author of the new binominal. N. L. Britton, John M. Coulter, Henry H. Rusby, William A. Kellerman, Frederick V. Coville, Lucien M. Underwood, Lester F. Ward, *Committee.*

At the meeting of the New York Academy of Sciences to be held on March 5th prox., will be held a debate between the supporters of the Neodarwinian and Neolamarckian theories of organic evolution. Prof. E. S. Poulton, of the University of Oxford, England, will open for the former, and Prof. E. D. Cope, of Philadelphia, will reply for the latter. Profs. W. B. Scott, of Princeton, and E. B. Wilson of New York, will also speak.

Prof. W. P. Wilson has brought to Philadelphia twenty-four car loads of exhibits, mostly of natural objects, which were displayed at the Chicago Exposition.